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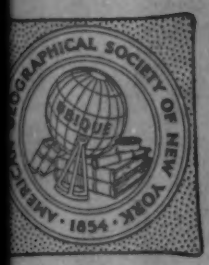

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THE
GEOGRAPHICAL REVIEW

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THE PACARAIMA-VENEZUELA EXPEDITION

H. E. Anthony, H. A. Gleason, and R. R. Platt*

IN southern Venezuela, just north of the Brazilian frontier, lies the almost completely unknown country of the Sierra Pacaraima. At the western extremity stands Cerro Duida, 7600 feet elevation, a tempting goal that remained unwon until the Tyler Duida Expedition carried out its successful exploration in 1928–1929.[1] At the eastern extremity, 400 miles eastward, is Mt. Roraima, 8600 feet, whose sheer cliffs were a barrier to exploration until Im Thurn in 1884 discovered a ledge that permitted ascent. But Roraima is days from the last outpost of civilization: only a few naturalists and explorers have ever reached its base; still fewer have made the ascent; and the first really comprehensive work was done by the Day Roraima Expedition, 1927–1928.[2] The observations and collections brought back by these two recent expeditions, organized by the American Museum of Natural History, made it clear that in Duida and Roraima we have areas of extraordinary interest, not only in themselves but in relation to each other and to the South American field at large. Both Duida and Roraima are isolated sandstone table mountains, physiographically and geologically alike in certain respects. A remarkable similarity has been noted between certain of their faunal and floral types, and some of these are closely related to well known Andean types.

Altogether the available evidence suggests the possibility that similar isolated mountains may occur more or less continuously

*H. E. Anthony, Curator of Mammalogy, American Museum of Natural History, and leader of the expedition; H. A. Gleason, Curator (for South America), New York Botanical Garden; R. R. Platt, Head of the Department of Hispanic American Research, American Geographical Society.

[1] G. H. H. Tate and C. B. Hitchcock: The Cerro Duida Region of Venezuela, *Geogr. Rev.*, Vol. 20, 1930, pp. 31–52. An expedition sent out by the American Museum in 1913 reached the base of the mountain but was unable to proceed farther because of the serious illness of one of the members of the party.

[2] G. H. H. Tate: Notes on the Mount Roraima Region, *Geogr. Rev.*, Vol. 20, 1930, pp. 53–68.

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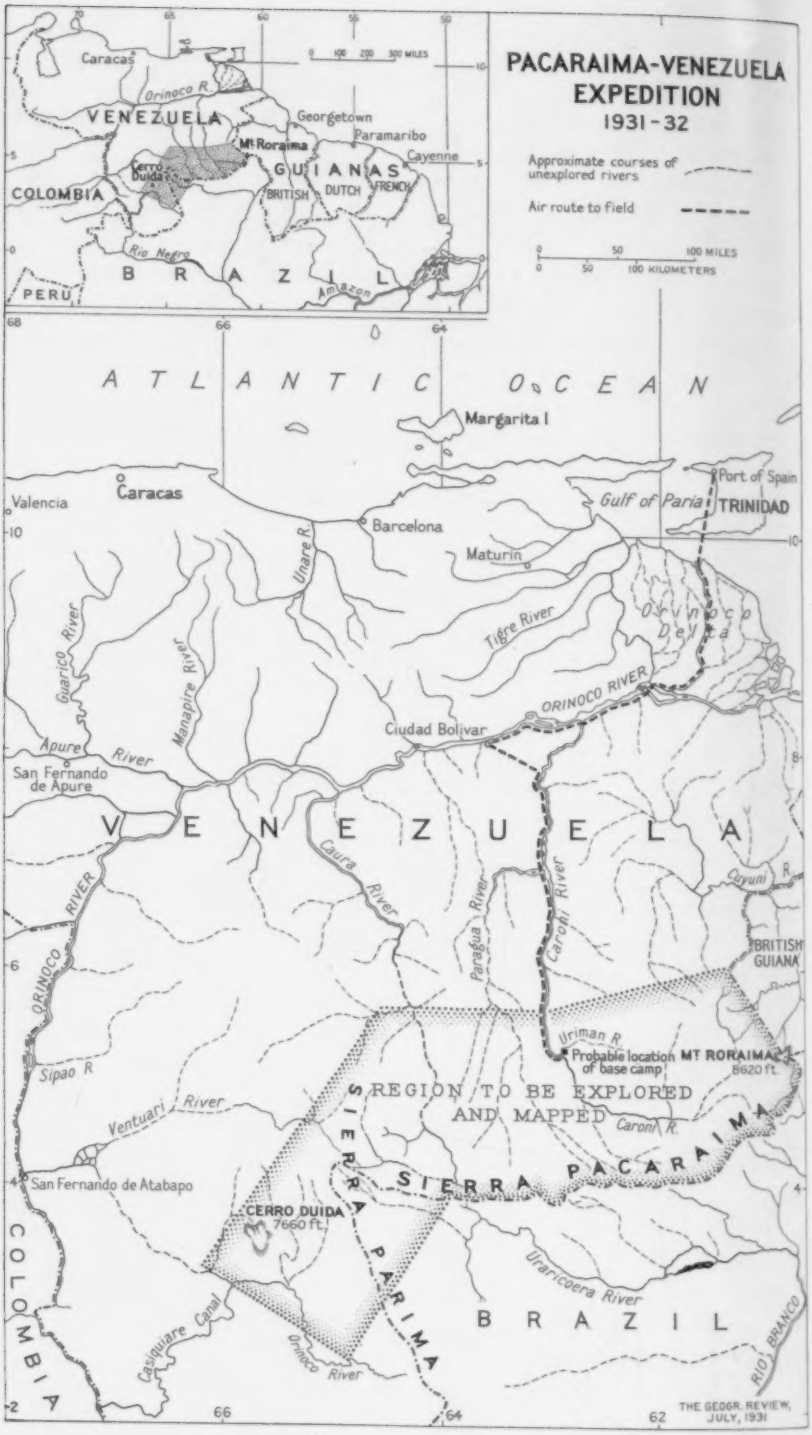


FIG. 1—The region to be explored by the Pacaraima-Venezuela Expedition. Scale 1:7,500,000.

throughout the 400-mile stretch of country between Roraima and Duida and that all are remnants of a great sandstone plateau stretching from the Andes across to British Guiana. The deduction has been confirmed by the discovery in 1930 of mountains of this type between Roraima and the northward-flowing section of the Caroní River.[3] Moreover, explorers in the territory between Duida and the Eastern Cordillera of the Andes of Colombia have also reported sandstone mesas at various places. This 40,000 square miles awaiting mapping and exploration offers, therefore, an exceptional invitation to explorer and scientist. The pioneer work of the American Museum of Natural History in the region and the coöperation given by the New York Botanical Garden and the American Geographical Society in the study of its results have led these institutions to organize a joint expedition for a thoroughgoing exploration of the region.

Organization of the Expedition

The expedition will be under the leadership of H. E. Anthony, with G. H. H. Tate, mammalogist of the American Museum, as assistant leader. Others of the scientific staff are G. A. Thorne, chief pilot and topographer, American Geographical Society; C. B. Hitchcock, topographer and geologist, American Geographical Society; W. B. Millar, Jr., geologist, American Museum; G. C. Graves, 2nd, geologist and pilot, American Museum; A. C. McKinley, aerial photographer and pilot, attached to staff of American Geographical Society; A. C. Smith, botanist, New York Botanical Garden; N. Y. Sandwith, botanist, Royal Botanic Gardens, Kew; C. H. Curran, entomologist, American Museum; A. G. Hassler, herpetologist, American Museum. The expedition plans to leave New York about the middle of August and to be in the field about six months.

It is the difficulties of travel that have kept the region a *terra incognita*. In former years the only method of attack has consisted of an approach by water up a tributary of the Amazon from the south, or an affluent of the Orinoco from the north, and from the foothills of the upland to push on afoot with Indians for packers. With but little in the region to supply an expedition with food, the mere matter of provisions alone has been a severe demand upon such primitive method of transport, while complete collecting equipment and accumulated specimens have proved too much for the uncertain facilities of Indian labor. The Indians are not numerous, they are not eager to work, and no large party has been able to press far beyond the navigable waters.

The airplane offers a modern weapon of attack. The expedition has decided to employ two transport planes and one scout plane,

[3] See "Notes on an Exploratory Journey in Southeastern Venezuela" by Desmond Holdridge in this number of the *Geographical Review*.

an amphibian. The base of operations will be Ciudad Bolivar, near the mouth of the Orinoco, and the first base camp will be established near the headwater of the Caroní. In a little over two hours the large planes can set down heavy loads of equipment and personnel in the very foothills of the territory to be explored, a journey which

FIG. 2—Cerro Duida with the Esmeralda ridge and savana in the foreground.

otherwise would take days or weeks, depending upon the condition of the river. Both pontoons and wheels will be carried as landing gear, and the planes will be able to use either waterways or savanas or forest clearings as landing sites.

PLANS FOR MAPPING

As a basis for plotting the various results of the expedition a topographic map will be made of the whole region by means of aerial photography. This in itself is a distinctly new feature in the exploration of new country, for rarely do explorers bring back more than traverses of their routes. Heretofore it has not been considered practicable, even on expeditions equipped with airplane transportation, to undertake mapping on this scale because of the expense involved by the usual method of vertical photography; and until recently methods by oblique photography have been applicable only in level country. This expedition, however, will use a rapid and inexpensive method by means of oblique aerial photographs developed by Mr. O. M. Miller of the staff of the American Geographical Society. It is described in an article in the April number of the *Geographical Review*.[4]

[4] O. M. Miller: Planetabling from the Air: An Approximate Method of Plotting from Oblique Aerial Photographs, *Geogr. Rev.*, Vol. 21, 1931, pp. 201–212.

It affords the detail necessary for general topographic maps on scales up to 1 : 250,000—a scale sufficiently large for preliminary maps of unsettled country.

To geographers the map itself will be one of the most important

FIG. 3

FIG. 4

FIG. 3—The walls of Roraima and talus forest from camp at 5200 feet.
FIG. 4—The walls of Roraima from camp at 7000 feet in the talus forest.

achievements of the expedition: 40,000 square miles of survey will materially reduce one of the largest of the blank spaces on the map of Hispanic America.[5] For the compilation of each of the sheets of the Millionth Map of Hispanic America in preparation by the American Geographical Society an average of more than 100 different surveys have been used. The aerial survey planned by this expedition will cover more than a third of one of these sheets and will be the largest single contribution ever made to the topographic map of South America.

The map will also cover some 400 miles of what is the longest

[5] Cf. R. R. Platt: Surveys in Hispanic America, *Geogr. Rev.*, Vol. 20, 1930, pp. 138–142; with map showing extent and character of existing surveys 1 : 30,000,000.

FIG. 5—A bell bird from Mt. Roraima.

stretch of international boundary in South America that is still completely unsurveyed—the Venezuela-Brazil boundary. In all boundary disputes in Latin America much of the difficulty in arriving at a settlement has been due to lack of accurate maps and the difficulty of making the necessary studies on the ground. Frequently, even after the work of demarcating a boundary line in the field has been undertaken, such major disputes as to the interpretation of the terms of the treaty have arisen that the whole case has had to be opened again for arbitration. With detailed maps of the boundary zone constructed from aerial photographs, it will be possible for boundary commissions to advance their disputes toward settlement and plot the main critical positions along an acceptable boundary line before going into the field to set up the conventional monuments.

THE PACARAIMA REGION FROM THE HUMAN STANDPOINT

Every new region is of interest to geographers because of the possibilities it offers for human settlement. Nothing is known of the mineralization of the Pacaraima country or of its forest resources. The possibility of developing the grazing land and of establishing agricultural communities—the last involving studies of soils, climate, and health conditions—are of equal interest. And then there is the problem of the aboriginal population.

In South America there are two major areas where savage tribes are still living in a state of nature—two regions that have never been visited by a competent anthropologist. One of these is the Pacaraima region which is to be explored by the expedition. Farabee's work among the Carib and Arawak tribes was no more than a preliminary survey covering the region to the east. Koch-Grünberg spent two years in the area to the north, but on his maps the Pacaraima area is repeatedly marked "Unknown Region."

There is some evidence that the Pacaraima range was part of an ancient trade route from the Guianas to the Chibcha and Inca empires and that a large part of the gold that was mined or washed

by the tribes of Guiana and the Orinoco found its way to the civilized peoples of the Andean highland. The solution of this problem of possible culture contacts lies in the direction of systematic archeological studies along the range of mountains stretching from Roraima to the westward. The very sketchy data that we possess from the region just south of Roraima show archeological remains of a type very distinct from the remains of the lowland peoples. Recent discoveries in Guiana seem to show that the civilization preceding that of the Aztec and Maya spread far along the northern coast of South America. It seems possible that it also spread to the interior along the open country of the plateaus.

FIG. 6—An undescribed plant from the summit of Cerro Duida.

The expedition will also take the opportunity of investigating the repeated rumors of pygmy tribes and of "white Indians" living along the height of land that separates the basins of the Orinoco and Amazon. One of the explorers of the sixteenth century actually reports that he came in contact with tribes of pygmies. His account is so convincing that the eminent Swedish anthropologist, Baron Erland Nordenskiöld, thinks there is some possibility that these people actually exist.

BOTANICAL ASPECT OF THE EXPEDITION

From the botanical standpoint the Pacaraima Mountains are the least known part of South America today. There may be other regions of equal or even greater size into which the botanist has scarcely penetrated, but there is every reason to believe that their plant life is essentially a repetition of the vegetation of the known regions surrounding them. The plant life of the Pacaraimas, on the other hand, is unique and constitutes a distinct floral province.

From the upper slopes of Mt. Roraima no less than 137 endemic species of plants have been collected, species not known to grow anywhere else. On the small flat top of Roraima 68 species find their only home. The expedition to Cerro Duida discovered 166 endemic species on its summit, as well as numerous others known

FIG. 7—A new tree, the flowers with large white bracts, from the summit of Cerro Duida.

before only from Mt. Roraima. We may conservatively estimate that at least a thousand additional species of unknown plants are still to be found on the numerous peaks between Duida and Roraima. The first botanical duty of the expedition is the discovery, the collection, and the publication to science of the numerous unknown plants, since here, as in every other case, all subsequent botanical work depends upon this preliminary knowledge of the flora.

Generally speaking, the plants of the tropics are not particularly showy, but those of the Pacaraimas are an exception. We already know that the flora of the region contains a high proportion of plants with beautiful flowers or attractive foliage, well worth cultivating in greenhouses in the northern states and probably hardy out of doors in the south. Among these may be mentioned *Orchyllium*, a flesh-eating plant with large bright blue flowers, *Bonnetia*, bushy shrubs with clusters of large pink flowers, *Ledothamnus*, shrubs of heathlike aspect with yellow flowers, *Bejaria*, with pink flowers much like our cultivated azaleas, *Episcia*, a foliage plant with variegated leaves, and *Elizabetha*, described by Schomburgk to be the most beautiful of all trees when in flower. The aerial equipment of the expedition will enable it to get seeds or roots of these and numerous other interesting plants back to New York without delay. There is also a possibility of the discovery of new and valuable medicinal plants.

The plants of the Pacaraimas have another interest which goes far beyond mere curiosity of discovery or value in medicine and horticulture. Plants are the descendants of their ancestors. Every species of plant has a history. What has been the history of this strange flora? What were their ancestors and where did they live? When and how and from what direction did they migrate into the Pacaraimas? How have they changed during the long slow processes of evolution? Why have they changed into these peculiar species? Is it because of the sandstone soil in which they grow or the cool climate of the mountains? Have they followed any regular or recognizable course of evolution, or are there any common structural features which they tend to exhibit as a result of their environment?

Even the few plants already known from the ends of the range raise many such questions that cannot be answered now. As a single example, the Pacaraima pitcher plants may be mentioned. The true pitcher plants are all American and include three genera, *Sarracenia*, with a dozen species in the eastern United States, *Darlingtonia*, with one species on the Pacific coast, and *Heliamphora*, with four known species in the Pacaraimas. What has been the history of these plants that has led to their segregation in three areas so widely separated?

FIG. 8—A new flowering tree from the summit of Cerro Duida.

Study of the history, geographical distribution, and relationships of the Pacaraima flora will not only aid similar botanical investigations in other parts of northern South America but will also furnish evidence to the zoölogists as to the origin of the animal life and even assist the geologist and geographer in their investigations of the geological history and physiographic development of the region.

THE FAUNA OF THE PACARAIMA REGION

The animal life of the Pacaraima region falls into two principal divisions, each of which is modified by differences in altitude and rainfall—forests and savanas. The lowland woods and grasslands are inhabited by mammals not greatly different from those of the bounding Amazonia and Orinoco. However, the interest of mammalogists will be centered primarily on the highlands—4000 feet and upwards—where markedly specialized forms of mammals may be confidently expected to occur. The basis for this prediction rests not only upon the presence on the plateaus of highly variant types of plants, insects and birds but also upon the known existence of distinct species of rodents and marsupials on the mountains bordering the western and eastern sides of the Pacaraima area.

In consequence of their altitude the sandstone table-lands enjoy a comparatively cool, rainy climate. Their summits may be almost as devoid of soil and vegetation as Mt. Roraima; or, on the contrary, as with Cerro Duida, they may be deeply covered with humus in

which are rooted the tangled and bizarre types of trees and shrubs found there by the expedition of 1928–1929. But few animals can support an existence upon the nearly barren Roraima table-land, such as do so being adapted to burrowing through moss and among the heathy tussocks of the summit. Of the flanks of the mountain little is known because a few years ago the forest, with its mammalian fauna, was wiped out by fire. On account of the nearly impenetrable brush and forest on Cerro Duida, the fauna can be sampled only with considerable difficulty, and hunting as commonly thought of is out of the question.

A problem of capital importance is the origin of the fauna and flora of the region. Did the creatures and plants inhabiting the Pacaraima highlands penetrate from the surrounding tropical lowlands, acquiring as they moved inwards adaptations in response to the new environment they encountered? Was there some highland connection between the Sierra Pacaraima and the Andes by which species already adapted to high altitudes and their attendant climatic phenomena may have reached the region? Again, may the Pacaraima highlands in certain cases have functioned as a dispersal center in which species became first differentiated and later found their way northward and westward into the Andes and southward to the mountains of Brazil? The problem as regards bird life is presented in the succeeding article by Dr. Frank M. Chapman to whose desire to attempt, by further exploration, the solution of the problem this forthcoming expedition is primarily due.

To the geographer the question is of particular moment in its bearing on the history of the land forms of the region. Today there is no known high elevation path from the Andes to the Pacaraima upland. The most promising offshoot from the Andes crosses northern Venezuela and sinks into the Caribbean to emerge as Trinidad. Animal wanderers along this highway are cut off by the extensive lowlands of the Orinoco Valley and would have to cross what is today a broad, tropical barrier, inhospitable to mountain life to reach the nearest part of our unexplored upland, the Roraima region. Yet these cool-zone, mountain-loving creatures did reach Roraima, and we know the Orinoco Valley is not a creation of yesterday. It is perhaps more logical to reconstruct an elevated contact with the Andes by the more direct route west of Cerro Duida. It is true that river valleys of low elevation cut between Duida and the mountains to the west, but the separation is neither so great nor of such implied antiquity as that at the east.

PROBLEMS OF THE RORAIMA-DUIDA REGION AS PRESENTED BY THE BIRD LIFE

Frank M. Chapman

American Museum of Natural History

WHILE the explorations of G. H. H. Tate[1] and others in the Mt. Roraima region and of Tate and C. B. Hitchcock[2] on Cerro Duida, Venezuela, have resulted in notable additions to our knowledge of the physiography, fauna, and flora of these regions, they have served chiefly to emphasize the importance of their contained physical and biological problems. Conditions heretofore believed to be restricted to the Roraima district have been shown probably to extend over an area of approximately 40,000 square miles, and the field as well as the nature of our inquiry have been correspondingly widened. With information and specimens from only two localities at opposite extremes of this territory we eagerly ask for descriptions of the country and specimens from its unknown interior. Does it hold still undiscovered "Roraimas" and "Duidas" whose structure will help reconstruct its physical history and whose life will assist us in solving the problems in origin and distribution presented by our present restricted knowledge?

What are these problems? I can attempt to answer this question only as an ornithologist. However, most birds, in spite of their mobility, are so responsive to the factors that determine distribution that they make as instructive indices of the boundaries of natural life areas as any other animal or even plants. A condor soaring over the snow fields of Chimborazo might in a few minutes volplane to the seacoast, but it is as definitely held to its true level as the lycopodiums of the páramo zone beneath it. Pennell finds that the life zones based on our study of birds in Colombia[3] "in general outline, and in nearly all details, . . . may be adopted for plants as for animals."[4] Let me therefore preface what I have to say of Roraima-Duida bird life with an outline of the more pertinent phases of our twenty years' work on the distribution of birds in the Andes. This will permit me to define the general principles of altitudinal distri-

[1] G. H. H. Tate: Notes on the Mount Roraima Region, *Geogr. Rev.*, Vol. 20, 1930, pp. 53–68.

[2] G. H. H. Tate and C. B. Hitchcock: The Cerro Duida Region of Venezuela, *ibid.*, pp. 31–52.

[3] Frank M. Chapman: The Distribution of Bird-Life in Colombia, *Bull. Amer. Museum of Nat. Hist.*, Vol. 36, 1917, pp. 1–729. See also, Charles C. Adams, The Zoögeography of Northwesternmost South America (after Chapman), *Geogr. Rev.*, Vol. 10, 1920, pp. 101–107.

[4] Francis W. Pennell: Scrophulariaceae of Colombia, *Proc. Acad. of Nat. Sci. of Philadelphia*, Vol. 72, 1920, pp. 136–188; reference on p. 140.

bution and, what is of equal importance, state the relations existing between the zonal bird life of the Andes and the Roraima-Duida region.

Altitudinal Zoning in the Andes

To see a snow-crowned mountain in equatorial latitudes is to behold an impressive demonstration of the effect of altitude on temperature. But the equally effective influence of altitude, working through temperature, on the vertical distribution of the life of the mountain is not so evident. In a word, it may be said that as we ascend from sea level to snow line in Venezuela, Colombia, Ecuador, and Peru, we pass through four distinct zones or strata of life—the tropical, subtropical, temperate, and páramo. The altitudes that mark their boundaries are determined chiefly by latitude, rainfall, slope exposure in relation to the sun and prevailing winds, topography, and proximity to and temperature of the sea; but, generally speaking, it may be said that the tropical zone extends upward to 4000 feet, that the subtropical zone lies between this height and 9000 feet where it is succeeded by the temperate zone which reaches to timber line at about 12,000 feet, while the succeeding, or páramo zone, finds its upper limits at the lower level of perpetual snow, or about 15,000 feet.

The tropical and temperate zones have both humid and arid divisions, the respective limits of which are determined by the amount of rainfall and relative length of the wet and dry seasons; the subtropical, or cloud, zone is a belt of saturation and condensation and is always humid. In the absence of sufficient rainfall it does not exist; and, under this condition, the arid tropical and arid temperate may meet in subtropical altitudes and produce puzzling complications in the distribution of their respective species. The páramo is also usually a cloud zone and hence is humid, but it lies at too great an altitude to permit of tree growth. It may be compared to the tundra of sea level.

The questions presented by the origin and distribution of the life of the basal or tropical zone are as old as the world itself and do not here especially concern us. It is in the upper life zones that our problems are found.

In Colombia and Ecuador it has been ascertained that about 230 species of birds are restricted to the subtropical, 140 to the temperate zone, and 30 to the páramo zone. These figures express not only the pronounced characteristics but the surprising localization of zonal bird life. That between the forests of the tropical and temperate zones there should exist a wooded strip only a mile or two in width to which over 200 species of birds are as closely confined as though their ranges were marked by physical barriers is an indication of

FIG. 1—The northwestern slope of Pichincha from an altitude of 11,000 feet. Foreground, a forest of the humid temperate zone, the bird life of which is of tropical origin. The treeless slopes immediately above timberline are in the páramo zone, and their bird life is chiefly of Patagonian origin.

the potency of those environmental factors that stimulate differentiation and determine the limits of faunal areas. In places these limits are extremely sharply defined. On one occasion, in the eastern Andes of Colombia, I walked from the humid temperate zone into the subtropical zone, experiencing an essentially complete change in bird life, within a period of five minutes.

In earlier publications I have repeatedly stated that the most significant fact to be considered in connection with this Andean zonal life is its comparatively recent origin. It cannot, as a whole, be older than the region it occupies and must therefore have been evolved since the latter part of the Tertiary. At this time the continent of South

America had essentially its present outline, and in its major aspects, at least, its bird life did not differ materially from that which exists there today. Hence it follows that not only can we assign to the Andes a geological birthday, but we can form some conception of the character of the avifauna from which their distinctive bird life has been derived.

Furthermore, as I have elsewhere remarked, the value of the Andes to the biologist is increased by the regional compression or concentration of the forces that control distribution and promote evolution and by the consequent definiteness with which these forces manifest themselves. In a study of the origin and distribution of their life we can associate cause and effect far more often than in those great continental areas where the early pages of geological and zoölogical history are lost in an incalculably remote past.

An Aid to the Study of Andean Life

Without attempting to summarize the results of the studies of Andean bird life it will further prepare the way for an attack on the problems presented by the fauna of Mts. Roraima and Duida if attention is called to certain difficulties encountered. These are principally due to the enormous length of the Andean area. Zoölogically, the Andes reach not only from Tierra del Fuego to Alaska but even enter Siberia. The basal ancestor of an upper zonal form may therefore exist in a region far from that occupied by its descendant. For example, the motmot of the subtropical zone from Colombia southward is believed to have originated in southern Mexico or Central America. The dipper or water ousel (*Cinclus*) of the subtropical zone in Peru appears to be of Old World origin. The ovenbird (*Cinclodes fuscus*) of the páramo zone in Colombia and western Venezuela apparently came from the plains of Patagonia. The short-eared owl (*Asio flammeus*) of the páramo zone in Ecuador is an emigrant from the northern temperate zone.

It is evident, therefore, that if we could discover a mountain area of sufficient height and size to develop a zonal fauna and circumscribed enough to avoid connections with remote areas, the study of zonal life would be greatly simplified, and the results of this study might assist both directly and indirectly in the analysis of Andean life. That is, one might discover in these isolated areas cases of unquestionable zonal origin and at the same time find facts relating to the evolution of Andean species. Such an area seems to have been found in the Roraima-Duida region. Even a restricted knowledge of it has thrown much light on certain phases of zonal evolution, and it is clear that further research will yield significant data relating to Andean life.

As might be expected, the zonal life of this insulated region is far more restricted than that of the Andes with its arms reaching to both the northern temperate and southern temperate zones. Thus on Roraima and Duida only 85 species of zonal birds have been found, whereas a corresponding area in Ecuador would yield not less than 300. In this connection it is interesting to note that the mountain mass of Ruwenzori in equatorial Africa is known to possess only 95 species of zonal birds, an indication of the limited area from which it has drawn its zonal forms.

Faunal Affinity of Roraima and Duida

Of the 85 known Roraima-Duida zonal birds, 62, either as the same or closely related representatives, are common to both mountains. I have elsewhere discussed the significance of this remarkable similarity in two upper zonal areas separated by 400 miles. But in view of the proposed exploration of the unknown intervening region it is obviously the part of wisdom to withhold further comment until more definite information can be had concerning the altitudes reached by the Pacaraima range.

In any event, the undeniable faunal affinity of Roraima and Duida makes it possible, for the present at least, to speak of their birds as a whole. Thus a distributional analysis of their 85 zonal species yields the following result:

Of tropical origin	22
With Andean relationships	38
With southeastern Brazilian relationships	2
With Guatemalan relationships	2
Of unknown origin	21

This analysis indicates that the age of the Roraima-Duida avifauna extends from that of forms derived from ancestors still existing in their basal or tropical zone, through a period where they are geographically distant but recognizable, to those of a past so remote that their ancestry cannot be determined.

Examples of Zonal Origin in Subtropical Birds

The first group supplies some of the most evident cases of zonal origin with which I am familiar. For example, the screech owl (*Otus choliba*) is widely and uniformly distributed throughout the tropical zone. It presents more or less geographic variation within this zone, but, with one possible exception, it is known to show zonal variation in South America only on Cerro Duida. The form from an altitude of 725 feet, at the foot of the mountain, is typical of the tropical zone race; but, at an altitude of 4700–5000 feet and hence within the sub-

FIG. 2—Zonal differentiation in Emberizoides. On the left, *Emberizoides sphenurus herbicola*, the smaller, paler form of the tropical zone; on the right, *Emberizoides duidae*, the larger, darker form of the subtropical zone.

tropical zone, four specimens were secured which in their colors and markings differ widely from their basal ancestor. They thus represent a before unknown race, and have been described as such (*Otus choliba duidae*).

The pigmy owl (*Glaucidium brasilianum*) presents a similar type of zonal variation. Specimens from the subtropical zone on Duida differ sufficiently from those of the tropical zone to be described as new (*Glaucidium brasilianum duidae*).

In both these and other similar instances our collection lacks specimens to prove the actual intergradation of the subtropical and tropical forms at the mergence of their respective zones; but in the case of a gray thrush (*Turdus ignobilis*) we have intermediate specimens which clearly show the passage of the tropical race (*arthuri*) into the subtropical race (*murinus*).

These birds are all forest-inhabiting, and habitat conditions on Cerro Duida permit of their continuous distribution (and hence intergradation) from base to summit. But a finch (*Emberizoides*) which is abundant on the savanas at the base of Duida has established itself in open growths of bromelias on the table-land of Duida where the intervening forests covering the slopes of the mountain prevent its contact with the lowland race. Apparently the resulting isolation, added to the effects of environmental change, has produced such pronounced variation from the tropical race that I have described the subtropical form as a full species (*Emberizoides duidae*).

The forests that prevail at the base and on the slopes and summit of Duida create more favorable conditions for zonal evolution than those that prevail on Roraima. Nevertheless on the latter mountain will be found the most striking illustration of this method of species-making known to me.

The common zonal sparrow of this region is the Andean whitethroat (*Zonotrichia capensis*). On the slopes of the mountain it is represented by one race but on the summit by another. The two forms are quite distinct, and their ranges are separated by only 1400 feet. But these 1400 feet cover a bare, vertical cliff[5] and lead to the

[5] See figures 3 and 4, p. 357, and the striking photograph in Tate, *op. cit.*, p. 54.

temperate zone conditions of the summit of Roraima where McConnell's sparrow is the only resident bird. Could one ask for a better illustration of zonal origin or a more convincing demonstration of the action of environment in holding a bird to its true faunal area?

Without going further into this phase of our subject it seems clear that the cases to which I have here called attention (and others could be added) are unquestionable instances of current evolution in which cause and effect are still so closely associated that the origin of a species is a demonstrable phenomenon.

It would lead us too far afield to discuss here the methods and the manner in which environment has expressed itself on these subtropical forms of tropical origin. But at least attention may be called to the fact that in all but one of the instances here mentioned the upper zonal form is larger and that in all they are darker than the forms from which they are believed to have been derived. In their differentiation they thus conform to the laws long ago laid down by zoölogists, that decrease in temperature is accompanied by increase in size and that increase in humidity produces darker coloration in the animals subjected to these conditions.[6]

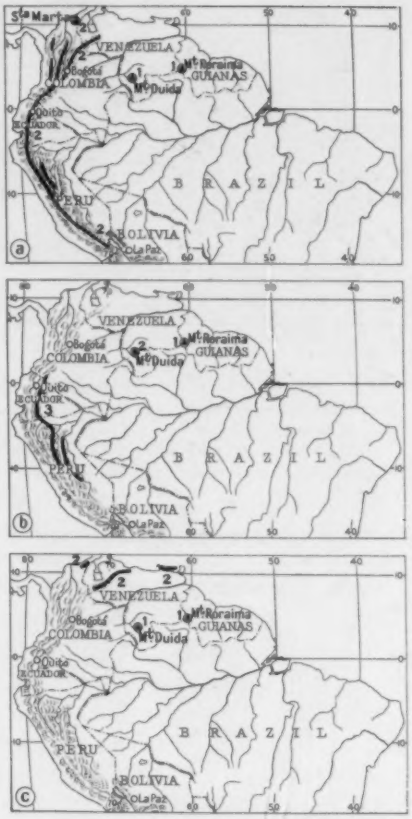


FIG. 3—a, distribution of a finch common to the subtropical zone of Roraima and Duida and the temperate zone of the Andes: 1, *Idiospiza homochroa duncani;* 2, remaining races of the species;

b, distribution of a toucan common to the subtropical zone of Roraima and Duida and of the central Andes: 1, *Aulacorhynchus derbianus whitelyanus;* 2, *Aulacorhynchus derbianus duidae;* 3, *Aulacorhynchus derbianus derbianus;*

c, distribution of a tanager represented in the subtropical zone of Roraima and Duida and of the northeastern Andes.

How these environmental factors exert their influence on the organism I shall not attempt to say, but in this connection attention may be called to recent researches demonstrating the power of temperature to promote mutation in *Drosophila*.

[6] See particularly J. A. Allen: On the Mammals and Winter Birds of East Florida, With an Examination of Certain Assumed Specific Characters in Birds, *Bull. Museum of Comp. Zoöl.*, Vol. 2, 1871, pp. 229–242; *idem:* Geographical Variation among North American Mammals, *Bull. U. S. Geol. and Geogr. Survey of the Territories*, Vol. 2, 1876, pp. 309–344.

FIG. 4

FIG. 5

FIG. 4—Distribution of the conebill to illustrate discontinuous distribution of the same species: 1, *Oxyruncus cristatus cristatus;* 2, *Oxyruncus cristatus hypoglaucus;* 3, *Oxyruncus cristatus brooksi;* 4, *Oxyruncus cristatus frater.*

FIG. 5—Distribution of a sword-winged hummingbird to illustrate discontinuous distribution of representative species: 1, *Campylopterus hyperythrus;* 2, *Campylopterus duidae;* 3, *Campylopterus rufus.*

ANDEAN ELEMENT OF RORAIMA-DUIDA AVIFAUNA

On the whole, then, it appears that with some exceptions the Roraima-Duida subtropical birds of tropical origin have been evolved under existing conditions, but when we pass to the second group, or birds with Andean relationships, it is at once evident that we are dealing with a much earlier period in the history of the Roraima-Duida fauna. The 38 birds in this group represent nearly one-half the known indigenous bird life of the two mountains and constitute its most distinctive element. The distribution and relationships of the Andean element may be summarized as follows:

Common to Roraima and Duida as the same form	19
Common to Roraima and Duida as representative forms	14
Known on Roraima but not on Duida	3
Known on Duida but not on Roraima	2
Represented in the Andes by the same form	4
Represented in the Andes by another subspecies	19
Represented in the Andes by another species	15

We should first note that only five of these birds are not common to both mountains. So close an agreement implies a common origin as far as this group is concerned. The faunal history of one mountain should, therefore, be that of the other. The Andean representatives of four of these birds occupy the temperate and, in two instances, also the páramo zone, though in Roraima-Duida they are found in the subtropical zone, a fact implying either climatic change or decrease in altitude in the latter group. The representatives of the remaining 34 inhabit the Andean subtropical zone.

Roraiman-Duidan and Andean Affinities Unexplained

These birds find their nearest relatives at a distance of usually more than 600 and, in some cases, more than 1000 miles. Nevertheless they outnumber those members of the Roraima-Duida fauna derived from near-by tropical ancestors by more than seventy per cent; a fact that indicates the greater age of the Andean element and also that when it was acquired the Roraiman-Duidan and Andean forms or their antecedents were more nearly in contact than they are today.

The 21 species of Roraiman-Duidan birds so distinct that we cannot trace their ancestry give no clue to the origin of the fauna of these mountains, and it is the close relation shown by the 38 birds with Andean affinities that constitutes the most valuable discovery thus far made by the ornithologist in this region. How can it be explained? In the light of present knowledge it cannot be explained. It might be suggested by those who think of birds as mobile creatures whose migrations carry them over thousands of miles that these zonal birds have flown from one mountain to the other. But this theory would not be entertained by any student of bird life. Some birds are as sedentary as others are migratory, and permanently resident species become so delicately adjusted to their environment that, as before remarked, they are as closely confined to it as though they were not possessed of the power of flight. Consider, for example, the two sparrows on Roraima whose ranges are separated by only 1400 feet.

Moreover, if Roraima and Duida have received their Andean element by flight from those mountains we should expect that Duida, being the nearer to the assumed source of supply, would have the larger number; but as our distributional analysis shows, there is essentially no difference in the Andean element in the life of the two mountains.

Further evidence opposed to the flight theory may be found in the indigenous flora of Roraima, which, like its bird life, has a strong Andean element. I. H. Burkill[7] states that 21 montane genera of plants are common to Roraima and the Andes. Seven of these extend as far as Chile and occur also in the mountains of southern Brazil, leaving fourteen restricted to Roraima and the Andes, none of which ranges south of Bolivia.[8] The close resemblance between most Roraima-Duida birds and their Andean representatives indicates that they were separated from each other or their common ancestors at no very remote period. Whether the geology of the two mountain

[7] I. H. Burkill: Introduction [to a Report on Two Botanical Collections from Mt. Roraima, British Guiana]. *Trans. Linnean Soc. of London*, Ser. 2, Vol. 6, 1901, pp. 1–17.

[8] The study of G. H. H. Tate's collections of plants from both Roraima and Duida, now being made by Henry A. Gleason, of the New York Botanical Garden, will doubtless throw much light on this problem.

areas, or that of the territory between them, contains any evidence of a recent connection between the mountains themselves remains to be determined. Fully to explain their faunal affinities such a connection would be necessary both in northeastern Venezuela as well as in Colombia.

It is my present belief that the facts at issue are no more to be explained by a mountain connection than they are by flight. Rather do I incline to the theory that the birds now common to Roraima-Duida and the Andes are the survivors of species which once occupied the intervening area, where, chiefly through the action of climatic causes doubtless due to glaciation, they have become extinct.

The evidence on which this theory rests is presented in a paper on the American Museum's collections of Roraima-Duida birds, now in press, on which I have drawn for the present article. But in view of the forthcoming Pacaraima-Venezuela Expedition it will be well to defer further speculation until we are in receipt of the specimens and information that this expedition is so well-equipped to acquire.

Questions to be Answered and Data Collected

We want, for example, to know if the region lying between Roraima and Duida contains a row of subtropical islands which might serve as stepping stones from one end of the chain to the other and thereby explain the close relationship of Roraiman and Duidan bird life. Or will these terminal mountains prove to be so widely separated that they may be considered as each independently representing a former area of which both constituted a part? If this is true, will the intervening area have distinct forms of its own?

We want to know whether there are any indications of a former connection between Duida and the Andes, and between Roraima and the mountains of northeastern Venezuela.

We want to know whether the Roraima-Duida area has been segregated in recent geologic times by an invasion of the sea.

We want to know whether the Parima Range, extending southward into Brazil reaches subtropical heights.

We want collections from throughout the tropical zone and from every subtropical locality in this entire region, not only for the light they may throw on methods in zonal evolution but for the contribution they may make to our knowledge of the Roraima-Duida region, as well as of its relations, both physiographic and biologic, to other areas and faunas of South America.

NOTES ON AN EXPLORATORY JOURNEY IN SOUTHEASTERN VENEZUELA*

Desmond Holdridge
Brooklyn Museum

AN exploratory journey into the country west of Mt. Roraima[1] was made by the writer in 1930. As this is practically virgin territory to explorers the following notes may be found useful

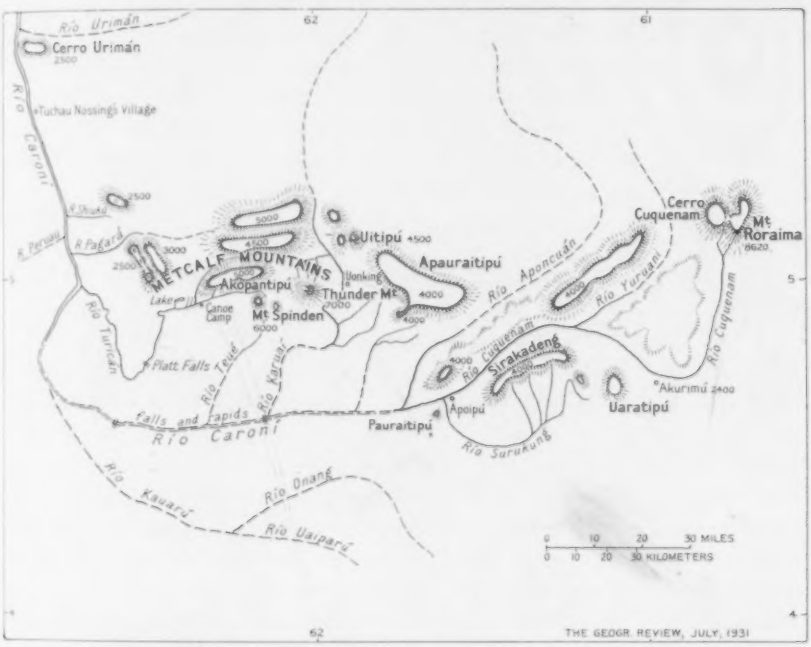


FIG. 1—Sketch map of the upper Caroní region. Rivers in solid lines from author's field sketches; courses in broken lines from local information. Altitudes in feet. Scale of map 1 : 2,500,000.

by subsequent expeditions. The writer's objectives, it should be observed, were mainly ethnological and archeological, and he was accompanied solely by Makushi and Arekuna assistants.

The starting point of the expedition was São Marcos at the junction of the Takatú with the Rio Branco, five to six days by river

*The expedition was made under the auspices of the Brooklyn Museum and was jointly financed by that institution and Rowe B. Metcalf, of Greenwich, Conn.

[1] Compare the preceding articles, "The Pacaraima-Venezuela Expedition," by H. E. Anthony, H. A. Gleason, and R. R. Platt, and "Problems of the Bird Life of Roraima and Duida," by Frank M. Chapman.

FIG. 2—The Metcalf Range from Uonking. On the left the eastern end of Akopantipú.

steamer from Manáos. Thence we proceeded on horseback northward through savana country to Akurimú, a matter of eight days. It was July, the height of the rainy season, which apparently extends from April to September; but the rainfall apparently is never particularly heavy, and the climate would be described as semiarid.

WEST OF AKURIMÚ

Akurimú, at an altitude of 2400 feet, is within plain sight of Roraima. It is the place marked Akurimupongong on Koch-Grünberg's map. The inhabitants are Arekuna, of the Taulipang branch of that nation. The chieftain, or tuchau, of the district is Andre, a cousin of Isaac, the Roraima chief, well known to all recent visitors to the Roraima country. He is thoroughly unscrupulous and not overfriendly. Akurimú is a station of the Seventh Day Adventist missionaries. It is difficult to obtain porters here, since the missionaries have preached against working for whites who do not keep Saturday as the Sabbath. Of the nine or ten hundred people under Tuchau Andre's sway none speak English and only two speak Portuguese, although these two speak it well. Cassava, yams, sweet potatoes, plantains, and sugar cane are obtainable, and likewise meat, as there are a few head of cattle stolen from Brazilian ranches.

The maps of the area west of Akurimú are quite useless. We proceeded to Apoipú, a village two days west of Akurimú. The route led through a country that was about one-third forested. The land gradually rises to an altitude of 4000 feet near Sirakadeng, the Mountain of the Stars. To the southwest the low mountains of the watershed are visible. Sirakadeng presents high cliffs to the observer from the south but drops down gradually to the bed of the Cuquenam on the north. It is an exceedingly trying country for horses: we were forced to abandon two.

Apoipú is a small village ruled by Tuchau Jach, a corruption

FIG. 3—The Karuaí Valley. Figure 3 forms a panorama with Figure 2.

of the English name, George. He is an amiable man of advanced years who is easily persuaded to secure bearers and supplies for such travelers as present him with a few yards of calico. Nevertheless, in 1926 he attacked and drove out a large party of Brazilian balata bleeders. The village is situated in a large, open plain, which affords a good landing place for an airplane since the ground is free from boulders and termite nests.

THE METCALF RANGE

From here we caught the first glimpse of a long wall of high cliff-faced mountains to the northwest, all reminiscent of Roraima. The highest of these is 7000 feet above sea level. The main part of the wall is called Akopantipú. The two mountains just to the south of Akopantipú I named Mt. Spinden and Thunder Mountain, respectively. The cordillera as a whole I termed the Metcalf Range. In regard to this nomenclature I would point out the extreme difficulty of rendering the native names in English phonetics with sufficient accuracy to make them recognizable when repronounced by a subsequent traveler. Furthermore, the place names change from generation to generation. The mountain Sapão is an excellent example of this, for a generation ago it was called Chakbang, according to the natives, and is so marked on older maps. It would be advisable to give all mountains and rivers that have not already become known by native names European names of one kind or another.

Apoipú is in latitude 4° 38′ N. This, as well as other latitudes along the route, was determined by observation with a sextant and artificial horizon.[2] Longitude was established by cross bearings of distant peaks whose positions had been fixed by observations from the

[2] Shortly before the writer's return a sketch map of the upper Caroní, made by Juan Mundo in 1927–1929, arrived at the American Geographical Society's headquarters, and while it furnishes only a crude pictorial idea of the country, without astronomical observations, it affords a good check since most of the newly added mountains and rivers appear on the Mundo sketch.

FIG. 4

FIG. 5

FIG. 6

FIG. 4—Tabular mountains, resembling Roraima, look down on the black waters of the upper Caroní.

FIG. 5—The western end of the Metcalf Range from near Uonking. On the right, Mt. Spinden.

FIG. 6—Another view of the Metcalf Range with Thunder Mountain in the foreground.

Amazon side of the watershed. They are approximate only. The whole course of the westward-flowing section of the upper Caroní is some thirty or forty miles south of its previously supposed position. The Aponcuán, Karuaí, and other right affluents of the Caroní are thus made very considerable rivers, while the left affluents are correspondingly diminished.

The Caroní, between the Kauarú and the Urimán, is inhabited by the Pishauko, a tribe of the Carib group with whom the Arekuna, Kamaragoto, and Maiongkong are almost always at war. As a result, it is very difficult to obtain porters to undertake a journey to the main river. However, Tuchau Joaquim, who lives at the base of Apauraitipú, enjoys the confidence of a number of the Pishauko and carries on trade with them. Since the Pishauko are exceedingly suspicious of strangers, the penetration of the country between Apauraitipú and the Caroní is best made under his guidance. *Carte blanche* from this chieftain is of inestimable value. He is of a friendly disposition and has probably traveled more widely in the region between Roraima and Duida than any other living man. He has trade relations with the Pishauko, Maiongkong, and Kamaragoto by whom he

is well received and he commands a large labor supply.

The land between Apoipú and Apauraitipú is interrupted by low ranges of hills between the streams that cross the trail. The average height of the extensive plain is 2500 feet. About Apauraitipú the grasslands are more or less level and free from boulders and other impediments to the landing of aircraft. The pasturage on these empty plains would support an enormous herd of cattle, and the country is certain to be a great meat supplier in the not very distant future. In the native villages supplies are readily obtainable; corn, bitter cassava, sweet cassava, purple yams, sweet potatoes, tanias, bananas, plantains, honey, and other commodities are to be procured in considerable quantities. The writer's party, which numbered about ten as a rule, was able to support itself entirely by provisions from the villages, procuring from the outside world only coffee and sugar; even tobacco was obtained from the natives.

FIG. 7

FIG. 8

FIG. 9

FIG. 7—Porters resting on the trail. Mt. Spinden in the background.

FIG. 8—The Karuaí, a large affluent of the Caroní, near Uonking.

FIG. 9—Platt Falls, a 260-foot drop in the Turicán, tributary of the Caroní.

The largest village in the district is Uonking, on the banks of the Rio Karuaí, a large affluent of the Caroní which rises in the same range of mountains as the Cuyuni. From the top of a range of hills in the vicinity it is possible to view the surrounding country for some

fifty or sixty miles. The savana ends between Mt. Spinden and Thunder Mountain, the forest boundary thence sweeping southward until it crosses the Caroní. From there it swings to the east and in the main follows the foothills of the north side of the Pacaraima watershed. To the west the forest stretches uninterrupted to the head of the Paragua, covering a gently rolling plain whose average height is 2500 feet. I doubt if any savana except small, isolated patches exists between Mt. Spinden and Mt. Duida.

With the exception of the mountains about Roraima and the Metcalf Range and one low, saddle-shaped mountain far to the west-southwest near the head of the Paragua, the whole plain was devoid of conspicuous hills. Even the Pacaraima range dwindled away into low ridges. I do not believe that any large mountains will be discovered between the upper Caroní and the upper Caura when that area is examined.

The Turicán River

From Uonking we proceeded westward to the Turicán River, which rises just north of Akopantipú and enters the Caroní in about latitude 4° 58′ N. Not far beyond the beginning of the forest near Mt. Spinden the land drops nearly a thousand feet at a steep angle, and the character of the forest also changes sharply. Instead of the dense jungle of the highlands we encountered the large trees characteristic of the Guiana lowland, mora, balata, and greenheart being abundant. On the same day that we left the savana we reached and camped at the junction of the Turicán and the Parutling.

The Turicán is a considerable stream about one hundred yards wide. It was descended to Platt Fall, where the river plunges 260 feet. Above the river is choked with rapids and falls, many of which are dangerous to canoes: below, it is slow and deep for the most part.

The Caroní is entered a day's journey below the mouth of the Kauarú. The river at this point is nearly a mile wide, and the water is black as that of the Turicán. Thence we continued to the headquarters of Tuchau Nossing, a short distance from the mouth of the Urimán. Two rapids had to be shot en route, both dangerous.

Our return to São Marcos was made over practically the same route. Tuchau Nossing's village is within nine days' travel of the mouth of the Paragua, and from the near-by town of the same name there is a line of motor trucks making frequent trips to Ciudad Bolivar. The route via Manáos, São Marcos, and Akurimú, however, is recommended as a means of reaching the Roraima country. The ascent of the Caroní is a difficult matter owing to the numerous rapids and falls.

THE ROADS OF WINDSOR*

Harold Fisher Wilson

St. Stephen's College, Columbia University

[With separate map, Pl. II, facing p. 396]

ALONG the Connecticut River through the township of Windsor, Vt., runs a newly constructed and much-used cement highway. To the west of the main artery a tributary system of roads focuses near the point where Mill Brook enters the Connecticut River. Windsor village is situated at this junction. Southwest of the village lies the monadnock of Mt. Ascutney, forming a barrier between Windsor and Weathersfield.

Drovers with sheep and cattle bound for the Boston market once traveled these roads that now carry a daily burden of milk trucks: once it was the farmer with horse and wagon jogging along on his infrequent trips to town; now it is the commuter speeding to his work in the Windsor machine shops. The changed fortunes of these roads it is our purpose to analyze.

The First Highway System

Mt. Ascutney has seen pass before it the history of the region: Indian bands paddling down the Connecticut to burn Deerfield; white pioneers pressing up stream; woodcutters hewing out the Crown Point Military Road across the heights of Weathersfield; permanent settlers clearing the land and building houses.[1]

After the close of the French and Indian wars in 1763, settlers quickly began to move up the river, but the population of 203 (Fig. 7) recorded in 1771 in Windsor was more or less of the squatter type. These adventurous spirits were followed by sturdy farmers from Connecticut, who formed the permanent stock of the Connecticut Valley Vermonter. Both valley meadows and upland regions were cleared and settled. By 1791 the population of Windsor had risen to 1542; and by 1810, to 2757.

A picture of the roads of the Windsor region as they were at the beginning of the nineteenth century is presented in the accompanying map (Fig. 2), information for which was found in "A Correct Map

* A field study made in the summers of 1929 and 1930 on a grant from the American Geographical Society as a part of its program of New England studies.

[1] Ernest W. Butterfield: The Early History of Weathersfield, Vt., pamphlet published in 1921, [in Windsor Public Library].

Henry Steele Wardner: The Birthplace of Vermont: A History of Windsor to 1781, Ch. 8, New York, 1927.

FIG. 1—View of present-day Windsor from Cornish, N. H.

of the State of Vermont from Actual Survey . . . &c." by James Whitelaw, published in 1810. On it are distinguished "public roads," the Connecticut Valley turnpike, which charged toll, the little sawmills and gristmills, and the meetinghouses.

This map shows that the early settlers did not consider it feasible to lay out their roads along the lower meadows and stream valleys. The difficulties of low ground were more of a handicap than the steep grades of the hills. For example, the "public road" from Windsor village to Reading Center climbs over the hills, crossing at right angles the streams of at least two good-sized brooks. In 1809 no public road followed Mill Brook valley, which today is the main route into the hinterland. The small sawmills and gristmills were served by private roads. These generally climbed up the hill and joined the "public road" between Windsor village and Reading Center. Forest and underbrush were lighter on the hillsides than in the valleys, and the soil was less damp and heavy. Moreover, at that time each farm unit was in large measure self-sufficing; communication with the market did not necessarily have to be easy and cheap.

In 1809 Windsor was divided into an "East Parish" and a "West Parish." A high ridge separated the township into these portions and developed two fairly distinct areas of settlement. Rather than build the meetinghouse near the center of the town, as was usually the custom, the citizens of the township built their "town-house" in Windsor village in 1774; and in 1785 they persuaded the Vermont Legislature to pass an act "Establishing Two Ecclesiastical Societies in the Town of Windsor."[2] But the ridge of land was still there, and disputes constantly arose between the two parishes over the place of the annual town meeting. Finally, in 1848, the legislature separated the township into Windsor and West Windsor.

The map of 1809 shows a toll bridge—still in existence—crossing the Connecticut River at Windsor village. It was constructed in 1796. It brought two towns on the New Hampshire side of the river, Plainfield and Cornish, into the Windsor area and also gave the region a direct road route to the Boston market. Some of the journals kept by those who collected the toll have been preserved, and they throw interesting side lights on local conditions, natural as well as social. In 1825 the toll gatherer, after remarking on the extremely dry weather, recorded in his entry of September 23, "Mill Brook so low the mills have stood still for 3 months."[3]

The toll bridge proved to be of much importance in the days before

Fig. 1—View of present-day Windsor from Cornish, N. H.

[2] For the history of the division of the town see Lewis C. Aldrich and F. R. Holmes, edits.: History of Windsor County, Vermont, Syracuse, N. Y., 1891, p. 300. Also Henry Steele Wardner, *op. cit.*, pp. 90 ff.

[3] Colonel Brown, toll gatherer in the Toll Bridge Journal for 1825: manuscript in possession of Henry Steele Wardner of Windsor and New York. On September 13, 1831, the toll keeper noted all the people were out for a "Wolf Hunt," but the next day they calmed their fears in a "Calvenistick Convention."

the railroad. On Tuesday, June 28, 1825, "Marquis Fayette passed with his suit." On Sunday, November 12, 1837, "Gen'l Lyman Mower," evidently a drover headed for the Boston market, went over the bridge with his following. In the entourage, says the journal, were "1 wagon, 1 sulky, 1 horse & rider, 600 sheep, 127 cattle."

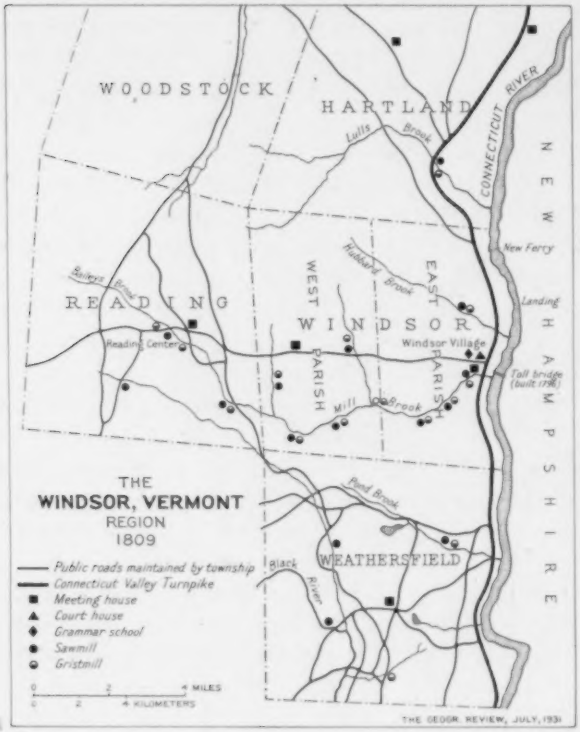


FIG. 2—The Windsor, Vt., region in 1809. Drawn from "A Correct Map of the State of Vermont . . ." by James Whitelaw, surveyor-general, 1810.

Special agreements were made with frequent users of the bridge, especially citizens of Windsor. In one dated January 1, 1811:

> Mr. Samuel Huggins [is] to pay a year for $3: himself, wife and a boy; afoot, horseback, or in pleasure carrages—and may fetch over with his team such as a side of Beef or have a doz Bufhels of grain or if he wanted to fetch a barrel or 2 of Cider—of his own raising, but this does not mean that he shall do teaming other ways than simply as above stated—for we do not consider the sum more than he ought to pay without any indulgence of a team.[4]

Another agreement of December 16, 1813, probably made with a man who was still in his "courtin' days," gave the right to

> Mr. Carlos Coolidge [a family name closely associated today with Plymouth, Vt., the township just west of Reading] to pasf the Bridge one year for $3, pleasure pasfing only and to have a lady with him if he pleases.

THE TURNPIKE AND THE STEAMBOAT

On the map of 1809 the turnpike following the Connecticut River is easily distinguished. The era of turnpikes in Vermont began during the last years of the eighteenth century and continued until the forties, when toll collecting except on toll bridges was finally done away with.

[4] The custom of getting a pass for a year is still observed.

In 1800 a charter was granted to the Connecticut River Turnpike Company for a road from Bellows Falls north to Thetford. There were to be four tollgates in that distance, at each of which the rates ran from 31 to 56 cents. It was provided, however, that "no one of the gates contemplated in this act shall be erected in the Town of Windsor."[5] By 1801 there was a weekly stagecoach up and down the Connecticut Valley. In 1807, three stages a week passed from Boston to Hanover, N. H., by way of the Connecticut Valley, and by 1822 one could journey from Windsor to Boston by stagecoach for $6.

The years following 1809 continued the rapid development of the region. The meadow lands in the river valley had all been taken up. There was a constant turnover and speculation in land and in farms: and values rose steadily. In 1823, in addition to the usual stores, the village could boast a bank, 3 churches, an academy, a gristmill, a woolen factory, 3 doctors, 8 lawyers, 2 printers, 2 booksellers, 2 bookbinders, a coach and chaise maker, a watchmaker, and a jeweler. Yet the village contained only 80 dwellings.[6]

The tide of rising land prices and immigration reached its crest soon after 1830. The panic of 1837 brought collapse of the land boom and heavy losses to those speculating in farm lands. By this time, too, New York State and the West had diverted the stream of settlers. By 1840 the population of Windsor had dropped from 3134 to 2744, and the other towns in the region were also declining (Fig. 7).

This period also saw the rapid rise and fall of steamboat navigation on the upper reaches of the Connecticut. Originally the river furnished the only means of communication with southern New England. Flatboats filled with produce from the newly developed frontier were floated down to Springfield and Hartford where they were broken up for lumber or occasionally poled back up the stream with merchandise. At Windsor steam navigation was never in a flourishing condition because of sandbars and shallow places. Freight rates were always high, and the river needed constant improvement. The larger part of the transportation of freight was by the flatboats of shallow draft. In 1849 the railroad gave river transportation its deathblow.

The Sheep Industry

Meanwhile, the road system kept the region connected with the Boston market. Over the roads plodded many flocks of sheep, the sale of which furnished the farmers the greater part of their income.

In 1813 merino sheep were introduced into the region by William

[5] Portion of charter quoted in Lyman S. Hayes: History of the Town of Rockingham, Vermont, Bellows Falls, Vt., 1907, p. 261.

[6] *The Vermont Journal* [Windsor], March 17, 1823, p. 2. The *Journal* files are in the Windsor Public Library.

Jarvis, who owned a farm at Weathersfield Bow on the Connecticut River nine miles below Windsor village. Jarvis had been consul at Lisbon and bought some of the royal flocks confiscated by the Spanish Junta.[7] The merino throve; and, as the sheep industry grew, mills were built to manufacture woolen cloth. A small carding mill on the

FIG. 3—Windsor in 1869 from the Cornish hills. From a lithograph, by courtesy of Mr. Guy Hubbard

upper fall of Mill Brook was enlarged into a textile mill. After the protective tariff of 1816 other woolen factories were built. In 1823 Zadock Thompson[8] notes one in Windsor, one in Reading, and two in Weathersfield. By 1831 West Windsor possessed a woolen factory. The keeper of the toll bridge recorded the number of sheep driven across the bridge. In 1825 he counted in round numbers 9500; in 1837, 13,000; in 1838, 14,000.[9]

In 1842 the governor of Vermont declared in his annual message, "Our citizens have become so dependent upon the growing of wool that this article may be said to be the staple of the State." Except on Mt. Ascutney, almost the last of the old-time forest cover vanished, and the landscape found its dominant note in the bold sweeping contours of pastured hills.

Sheep and wool allowed the Windsor region to hold its own for a decade or two after many New England farming regions had succumbed to industry or to the competition of Western land. An observer in 1867 stated:

> It is a vindication of the agriculture of the successive generations that the farms of the town have improved with the lapse of time . . . With an elder brother,

[7] Mary Pepperell Sparhawk Cutts: Life and Times of William Jarvis, New York, 1869, p. 272.
[8] Zadock Thompson: A Gazetteer of the State of Vermont, Montpelier, 1824, pp. 227–294.
[9] Richard T. Dana: The Bridge at Windsor, Vt., and Its Economic Implications, New York, 1926, p. 13.

I visited Windsor that we might look once more on the scenes of our boyhood . . . We ascended the interior hills of the town, for Windsor and West Windsor are all one to our memory . . . Everywhere we met signs of improved agriculture, of thrift and comfort, of contented and prosperous industry.[10]

In the accompanying map (Pl. II), compiled from material taken

FIG. 4—Windsor in 1886. From a lithograph, by courtesy of Mr. Guy Hubbard.

from a Windsor County atlas published in 1869, a picture is given of the development of the region in the sixty-year period following 1809.[11] This map of 1869 was made at about the period of the fullest development of the countryside and the network of local roads. The farms are all occupied, and the villages of Reading Center and Sheddsville, today abandoned, are thriving. Rural schools, blacksmith shops, and small woolen and woodworking factories dot the district, and public roads have been vastly extended. In 1869 roads indeed follow the valleys, but the slow-moving farm wagons could still make as good time by climbing over the hill road from Sheddsville to Windsor as they could by following the more roundabout Mill Brook valley route.

CHANGING CONDITIONS

After the Civil War the drastic drop in the price of wool gradually forced many of the smaller country woolen mills to close down or curtail production. Flocks decreased, and the general prosperity of the countryside suffered correspondingly. The decline of wool growing was gradual, however. Sheep husbandry was important even as late as 1884. The compiler of the "Gazetteer of Windsor County,"

[10] Sewall S. Cutting: Centennial Memorial of Windsor, Vermont, July 4, 1876, Windsor, 1876, p. 38. In the Windsor Public Library.

[11] F. W. Beers: Atlas of Windsor County, Vermont, New York, 1869.

published in that year, gathered a detailed list of the farms and other enterprises in each township. The small township of West Windsor, which contained 83 farms averaging 140 acres, shows 60 flocks of sheep totaling 6741—an average of more than 112 sheep to a flock. Most farms still had sheep and depended mainly on the sale of wool.[12]

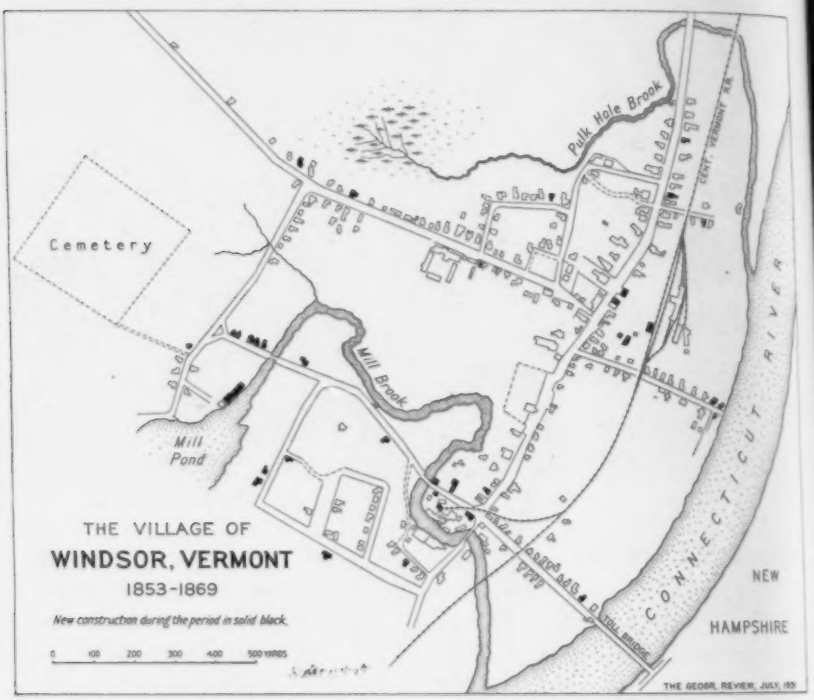


FIG. 5—Map of the village of Windsor based on Presdee and Edwards' map of 1853, hanging in Old Constitution House, Windsor, and on Beer's map in the County Atlas, 1869.

The questionnaire in the Gazetteer covered only three points: the number of sheep on the farm; the number of acres; and the number of trees in the sugar orchard. Maple sugar was evidently considered the second most important farm product.

The West Windsor woolen mill, now no longer in existence, was still in operation in 1884 and with but four looms and twelve hands was turning out "25,000 yards of plain and fancy cassimeres per annum."

Similarly, Reading township contained industries which today are nonexistent. Although the woolen mill there no longer manufactured cloth, the town was taking good advantage of forest resources. In the hamlet of Felchville a chair factory employed twenty-five men and turned out 144,000 chairs a year, while another small factory

[12] Hamilton Child: Gazetteer and Business Directory of Windsor County, Vt., 1883–84, Syracuse, N. Y., 1884, pp. 541 *et seq.*

made 150,000 rakes a year. In South Reading one mill made 100,000 mop handles a year, as well as "clothes' frames, ladders, etc.," and another mill put out 250,000 mop handles a year, as well as 500 cider barrels and "much chair stock."

The last years of the eighties brought a decided change. Introduc-

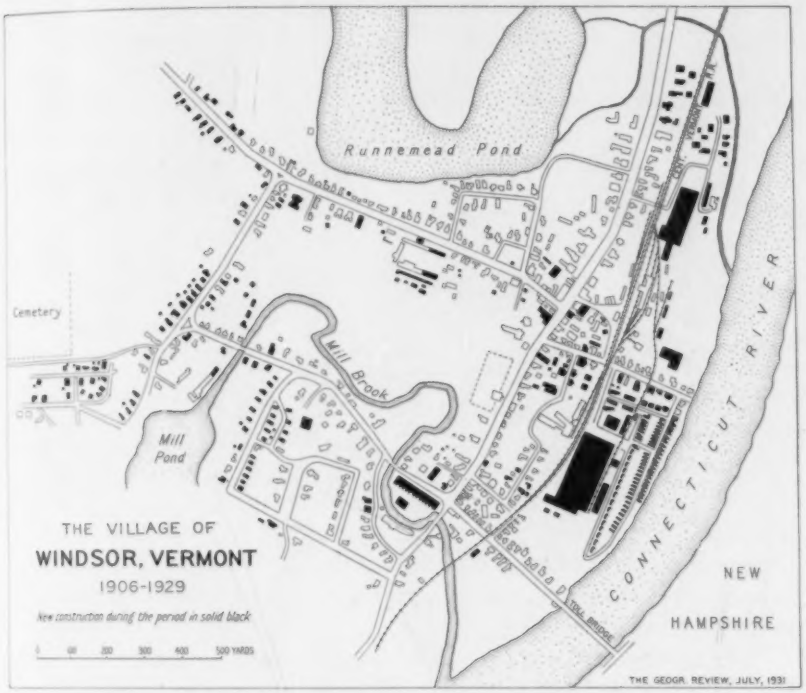


FIG. 6—Map of the village of Windsor based on the author's investigations in 1929.

tion of Australian mutton, the free ranges of the West, the manufacture of shoddy by large urban mills, and the removal of the tariff on wool gradually brought an end to wool growing in the Windsor region.

THE DAIRY INDUSTRY

The railroad came into the region in 1849 but had no effect of profound importance until the rise of dairy farming. In the Windsor region the dairy industry began late. In 1884 cows were unimportant, the farmers usually having only a few for their own use. Mr. Galen Waite of Windsor, who farmed 350 acres until 1900, had a flock of sheep numbering at different times from 300 to 600 and tapped 800 sugar trees but kept only one cow all his days.

Commercial dairying grew out of the agricultural crisis following the disappearance of the sheep industry. A creamery built in 1889 immediately found a favorable market in Boston for its butter. Dairy

herds began to increase, and farmers as far away as Hartland hauled milk daily with horse and wagon to the creamery. About 1900 Boston milk dealers began to penetrate into southern Vermont and New Hampshire for dairy products to supply the increasing city demands. Somewhat later a milk car, sent out by a Boston dealer, passed through Windsor and collected local milk from the railroad station.

TABLE I

TOWN	NUMBER OF SHEEP		NUMBER OF MILCH COWS	
	1921	1925	1921	1925
Windsor	92	51	492	493
West Windsor	123	103	701	790
Reading	241	136	243	426
Weathersfield	328	117	1088	972

Between 1909 and 1919 the amount of Vermont milk sold increased 62 per cent, and by the latter date the state, with $77 worth of dairy products per capita, led all the United States, Wisconsin coming second with $68 per capita. Fresh milk thus became the greatest factor for agricultural revival in the Windsor region. Table I, from the reports in the State Agricultural Department publication "Agriculture of Vermont" (1920–1922 and 1924–1926), indicates to some extent the shift from sheep to cows.

The agricultural crisis was felt most severely on the upland farms. Here dairying was out of the question as the distance to the railroad was too great. By degrees the farmers moved away. Whole districts in the towns of Reading and Weathersfield became uninhabited. Roads were washed out, and the locality became inaccessible. In the towns of Windsor and West Windsor, while deterioration did not go to such extremes, many farms were abandoned, and even on the best farms some land went back to forest. A few cattle could not keep clean the pastures that had been cropped close by large flocks of sheep. Pine, hemlock, and birch speedily seeded in, and during the next forty years the forest regained many of its lost hillsides. It continues to encroach, for a half-grown stand of pine is worth more as prospective lumber than the cost of bringing it back to pasture.

The extent of settlement and occupation as it is today is pictured on the accompanying map (Pl. II), made by the writer after a survey of the area in August, 1929. The maps of 1809, 1869, and 1929 thus give an opportunity to compare the district at sixty-year intervals. The predominance of red in northwest Reading and in portions of Weathersfield and West Windsor on the present-day map indicates

the amount of territory reverting to forest. Within the last sixty years the mileage of the roads has materially decreased.

Accessibility to market now became of first importance, and it was the valley roads that received the stress of upkeep and of improvement. The decrease in the roads kept in repair is shown on the map (Pl. II). No road that serves as an important route of outlet for any family is abandoned by the town, though degree of maintenance varies greatly. The decrease in mileage has given better opportunity for each town to give more careful attention to the remaining roads. The township of Weathersfield, whose population has been gradually declining ever since the middle of the last century,[13] has about 108 miles of highway to maintain. In contrast the township of Windsor, much larger and more prosperous in every way, has but thirty-eight miles. Although the state helps maintain the state highway and gives help for certain other roads, there is no centralized administration to aid the poorer town that has a disproportionate mileage of back road.

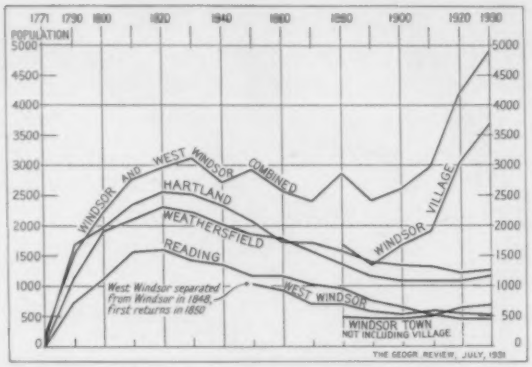


FIG. 7—Graph showing the movement of population in Windsor and adjacent townships and in Windsor village.

INDUSTRIAL GROWTH OF WINDSOR VILLAGE

From the time Asahel Hubbard migrated from Connecticut to Windsor in 1800 and there built his experimental pump, the town had been the home of various ingenious inventions.[14] The underhammer rifle, invented there in the thirties, led to the construction of machinery largely eliminating hand work in rifle making. In 1844 the war with Mexico was imminent, and a contract from the Federal Government was obtained. The number of employees in the Windsor shops by that time reached three hundred.

The first real "boom period" for the village occurred between 1853 and 1869 under contracts with the British Government during the Crimean War and contracts with the Federal Government during the Civil War. All the houses were filled, and some new building was

[13] See Fig. 7. It will be noted that Weathersfield has gained slightly in the 1930 census. This is probably due to commuters who live in Weathersfield and drive to Windsor or to Claremont to work.

[14] Compare Guy Hubbard: The Influence of Early Windsor Industries upon the Mechanic Arts, *Vermont Historical Soc. Proc. for the Years 1921, 1922 and 1923*, Montpelier, 1924, pp. 159–183.

done. This new construction is shown on Figure 5, which was made by comparing an 1853 map of the village, now hanging in the Old Constitution House in Windsor, with a map of 1869, printed in the Windsor County atlas of that date. After these war periods the industry of Windsor declined. In 1870 the building used for rifle manufacturing was transformed into a cotton mill, furnishing employment to some 400 persons, until in 1888 it failed because of financial mismanagement.

In 1896 a corn-canning factory was built. It was then the largest of its kind in New England, having a capacity for 1,200,000 cans annually. It now generally employs from fifty to sixty hands during the canning season, while sweet corn furnishes to many farmers a cash crop second in importance to milk.

In 1904 the Windsor machine shop, established in 1888, was bought by outside interests. A large industry developed in the manufacture of automatic lathes. Windsor now entered upon its second "boom period." In 1908 the old shop by the waterfall on Mill Brook was given up for a large new plant built on the spacious river meadow, more accessible to the railroad. In 1905 there were 30 machinists and mechanics in the town of Windsor and 74 farmers and farm laborers. By 1913 the number of machinists had more than tripled, while the number of farmers and farm laborers had decreased to 54.[15]

The World War brought a sudden development in industry. Machinists and mechanics employed in the shops increased by the middle of the war to more than 1600 men, working in day and night shifts. Two foundries were built, and soon another company manufacturing automatic machinery came into existence. In August, 1929, the total weekly pay roll of the four main Windsor industries amounted to $51,380, and the total number of men employed was 1922.

The growth of the village during the period 1906–1929 is pictured on the map, Figure 6. The new machine shops required far more labor than was available locally, and hundreds of employees were brought in from outside. The first contingent of the large foreign population now in Windsor village had arrived with the Irish construction gangs in 1849. The cotton mill in the seventies imported whole families of French Canadians. The latest foreign contingent are in large part Poles and Russians. Housing facilities were wholly inadequate; and, after a shanty-town period, the largest machine company built a factory suburb of small and cheaply built dwellings—a crowded slum adjoining a country village.

The earlier Irish and French families had by this time become fairly well assimilated. This new mass of wholly foreign population was a different matter. There followed a corresponding influx of

[15] W. E. Shaw: The Hartford, Windsor, and Woodstock, Vermont, Directory, 1913, White River Junction, Vt., 1913.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—The hills of West Windsor. Mt. Ascutney in the background; on the left an unoccupied farm.

FIG. 9—Unoccupied hill farm above Reading Center. The road in Figure 11 goes by this house.

FIG. 10—The hills of northwest Reading.

FIG. 11

FIG. 12

FIGS. 11 and 12—Public roads of 1809. That in Figure 11 is now abandoned; that in Figure 12, originally the main highway from Windsor to Reading Center, is used by the R. F. D., but no farms are now dependent on it.

foreign shopkeepers—Italians, Greeks, and finally Jews—so that the place took on for the first time the mixed character of a cosmopolite factory town. To the village all this brought prosperity but also greatly increased competition for the old-time merchants from newcomers and invading chain stores.

High wages now drew away the farm hands from the surrounding farms, and the farmers' sons were attracted by the shop. During the World War practically the whole supply of local farm hands was drawn into the shops. The effect was severe. Farming as practiced in Vermont cannot be done profitably on a one-man basis, nor could farms pay wages comparable to those of the factories. Many farmers had already turned for employment to the shops. With no farm hands to be had, many others gave up and followed the same road, frequently living on the farm and commuting to the shops to work. For a time there appeared the prospect of an agricultural community ruined by a manufacturing prosperity that in itself was not altogether stable or permanent.

THE INFLUENCE OF THE AUTOMOBILE

In the last decade, however, the life of the countryside has been in some measure revivified by the development of milk-gathering routes into the country, by the construction of hard-surfaced trunk-line roads and the improvement and better maintenance of the side road "feeders," and finally by the advent of the rural commuter who lives in the country and works in the village shops.

In the decade following the war the use of the automobile reached such a point that Windsor village, like its neighbors in the valley, became practically motorized.

Nearly all the horse-drawn vehicles gave way to motors; even the farmers, who continued using horses for farm work, relied on cars for traveling on the roads. Windsor came to be supplied with meat, bread, and fruit by trucks sent out daily from larger towns near by, which served as distributing centers. Gasoline and oil no longer came by railway alone.

The blocking of roads by snow in winter showed how much more dependent the village had become on these neighboring communities and, correspondingly, made clear the necessity for maintaining the roads in all seasons. After a few years of experimenting the tractor plow, properly handled, has accomplished what had seemed wholly out of the question in the past. At first the winter roads were kept clear of snow only within a short radius of Windsor village. Later the main roads up and down the Connecticut Valley were cleared to a point where the plows of neighboring towns took up the work. From year to year the area attacked by snowplows increased rapidly, until all the well traveled roads are now kept open to motor traffic.

FIG. 13

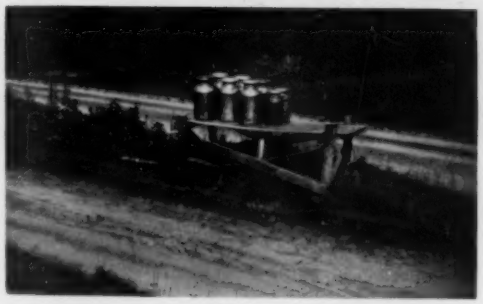


FIG. 14

FIG. 15

FIG. 16

FIGS. 13–16—The new concrete road passing through Windsor; and the related industries—milk collection, furniture store, and greenhouse—served by truck.

With the increase in road traffic a different standard began to be demanded for the roads in all seasons. With state and Federal aid stretches of concrete were laid down, until now the cement road reaches from Ascutneyville to White River Junction. All of this has been laid within the last five years, the last strip being completed in the summer of 1930. Better roads have thus radically altered the Windsor area.

FIG. 17—Map showing present development of the dairy industry in the Windsor region.

MILK GATHERING

With an automobile and better roads it became possible to deliver milk from much greater distances to the morning milk trains. It was now possible for the farmer who was once out of reach of the railroad to maintain himself by dairying. When there was no company or creamery truck to carry the milk in day by day, farmers often took turns or even occasionally clubbed together and operated a truck jointly. A recovery in the price of milk gave new encouragement to the farmers of the region, and even with very small herds it became possible and worth while to ship milk regularly.

In the middle of the last decade a creamery at Bellows Falls took the step of extending its region of supply by operating milk trucks regularly over the back country. One such line, for instance, runs from Bellows Falls northwest through Reading, roughly paralleling the railroad; another one makes a circle through Weathersfield; while another covers territory in Hartland and northwest Windsor (Fig. 17). In the remaining town in the Windsor region, West Windsor, a Boston company has established a collecting route and brings the milk in by its own trucks to the railroad station at Windsor. The cartage rates in the Hartland-Windsor district range from 35 cents a hundred pounds

for the farms that are nearer Bellows Falls up to 50 cents a hundred pounds for the more remote farms. As shown on the map, more territory is covered during the summer months.

With the increased dairy industry, too, has come a marked rise both in price and in demand for local dairy cows. The Vermont climate is favorable to cattle raising, and the state campaign for the eradication of bovine tuberculosis has brought Vermont cows a good name outside the state. Outside buyers periodically drive through, seeking good-grade cows, and there is a constant demand from large dairy farms in urban regions at prices which make it advantageous for the farmer to raise his calves to maturity when his barns and his supply of hay allow it.

FIG. 18—"Commuters' map" of Windsor. Only the roads used by commuters are shown.

These various circumstances have led to a gradual recovery of agricultural prosperity on most of the farms now occupied. In spite of many handicaps and discouraging factors, within the past five years the price of really good farms has nearly doubled, more farms are shipping milk, and herds as well as the amount of milk shipped from the region have increased.

THE COMMUTERS

Changed conditions of time and space have also made a marked difference in the life of the machine-shop employees and have developed a type that may be termed the rural commuter.

The plowing out of the winter roads has affected the factory worker as well as the farmer. The very rapid growth of the village caused

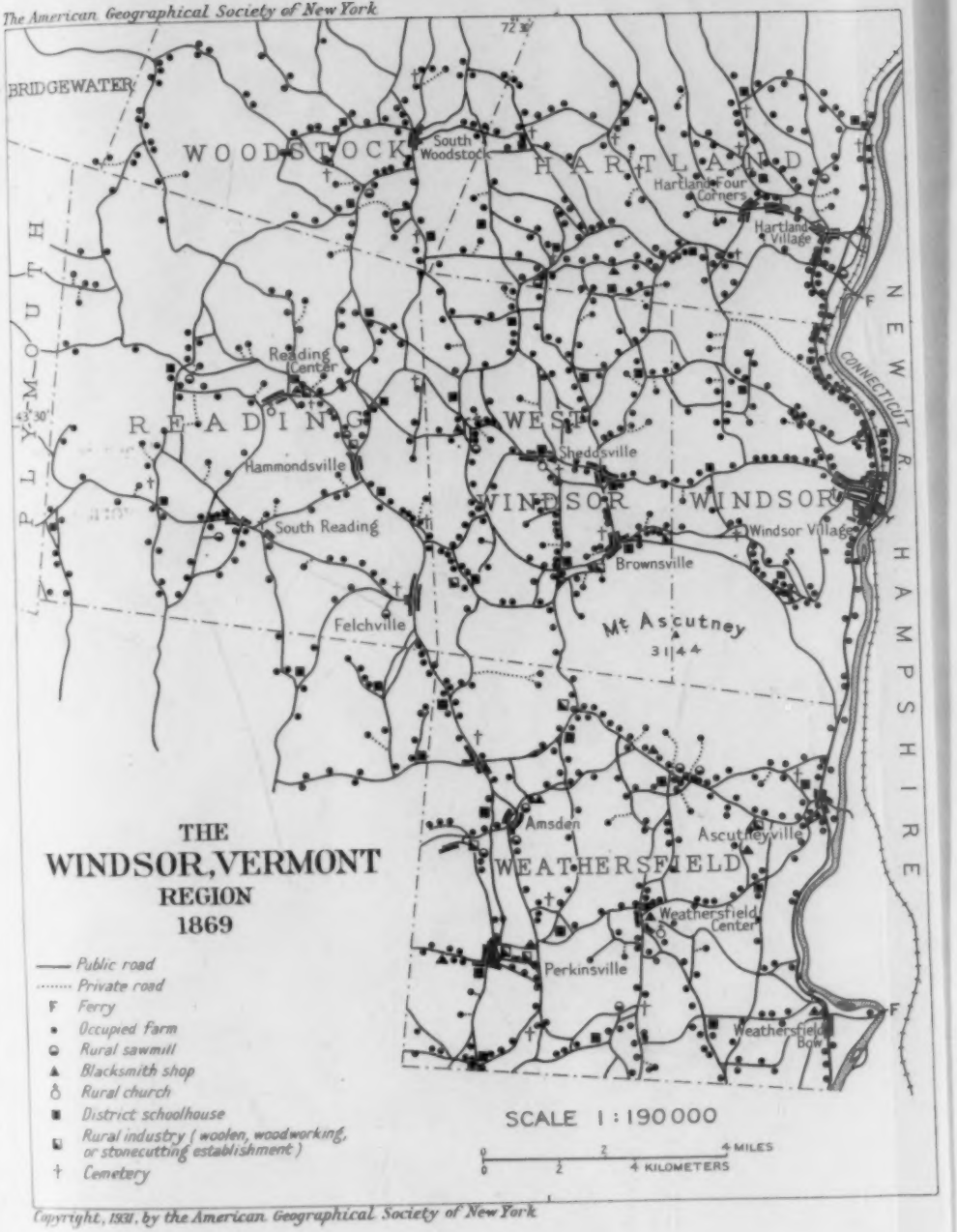
a scarcity of living accommodations (Figs. 6 and 7). In Windsor, according to a resident, the average worker, whose wages were about $27 a week, usually paid for rent about $25 a month, or $300 a year. If he built a house in Windsor the $300 would not cover interest, taxes, lights, insurance, water, and upkeep on a $3000 house; and what could be built for $3000? Entire back-hill farms with buildings thereon could be purchased for less than that. Study of the personnel in the Windsor machine shops in August, 1929, indicated that a large proportion of shop workers lived outside the village and drove to Windsor to work. The second largest establishment in the village was then employing 381 men, thirty-five per cent of whom commuted to Windsor to work, nearly one-half of them from Claremont, N. H.

In the oldest and largest machine establishment in the village twenty-eight per cent of the 1383 employees in August, 1929, were commuters, more than one-fourth of whom came from Claremont, N. H. These workers had found employment in Windsor but no living quarters, and as a result they commuted from Claremont. This is a different type from the rural commuter. Here is a town-dwelling workman who remains one, merely working at a considerable distance from the town in which he lives. As soon as work in Claremont picks up or work in Windsor lessens or quarters in Windsor village become available, the ten-mile journey over the road is abandoned. His case is of interest, however, as indicating the far closer interrelation than ever before between the industrial towns up and down the river valley.

Another type of commuter lives in villages such as Ascutneyville or Felchville and drives to Windsor to work. Formerly many of these commuters lived in Windsor; now they have gone out into the neighboring villages to live, where cheaper rent and pleasanter conditions can be found.

The third type, the rural commuter, includes the farmer that now works in the machine shop while still living on the farm and the shop worker of Windsor that has sought escape from the crowded tenements. A demand developed for "little places not far from the village," not for the shop worker to farm but where he may have "elbow room"—a garden, a potato patch, a cow, a pig, hens, and perhaps a wood lot. The supply of these "places" and even of available building sites was quickly exhausted. As roads became usable in winter and automobiles came within the purchasing power of the shop worker the house hunter went farther afield.

Experience has shown this change to be for the better in almost every respect. The cost of commuting is not onerous. Five or six men often share the expense of operating the car or the owner of the car jitneys his neighbors back and forth with him at a "reasonable figure." The shop worker tends to buy his dwelling and to become



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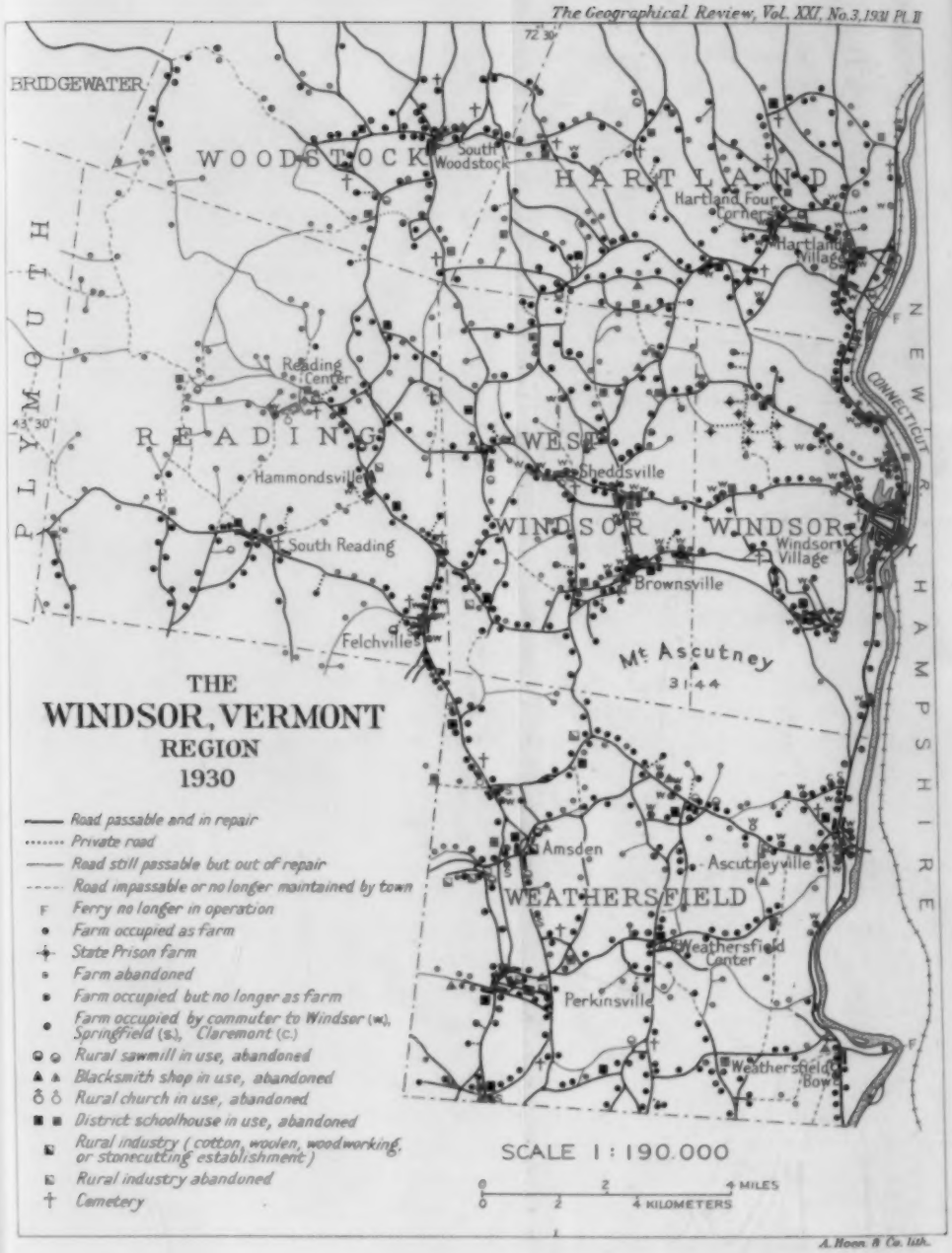
72° 30'
43° 30'
BRIDGEWATER
PLYMOUTH
WOODSTOCK
South Woodstock
HARTLAND
Hartland Four Corners
Hartland Village
NEW HAMPSHIRE
CONNECTICUT R.
Reading Center
READING
WEST
Hammondsville
Sheddsville
WINDSOR
WINDSOR
Windsor Village
South Reading
Brownsville
Felchville
Mt Ascutney
3144
Amsden
Ascutneyville
WEATHERSFIELD
Weathersfield Center
Perkinsville
Weathersfield Bow
THE
WINDSOR, VERMONT
REGION
1930
Road passable and in repair
Private road
Road still passable but out of repair
Road impassable or no longer maintained by town
Ferry no longer in operation
Farm occupied as farm
State Prison farm
Farm abandoned
Farm occupied but no longer as farm
Farm occupied by commuter to Windsor (W.), Springfield (S.), Claremont (C.)
Rural sawmill in use, abandoned
Blacksmith shop in use, abandoned
Rural church in use, abandoned
District schoolhouse in use, abandoned
Rural industry (cotton, woolen, woodworking, or stonecutting establishment)
Rural industry abandoned
Cemetery
SCALE 1:190,000
0 2 4 MILES
0 2 4 KILOMETERS
A. Hoen & Co. lith.

an independent proprietor rather than a perpetual rent payer. He lives in greater comfort, saves more, and rears his children under better conditions. Thus permanently established, he becomes a more valuable type of employee than the "floating labor." Not the least of the good results is that often a small and dwindling farm is saved by the rural commuter from being abandoned. The change means the survival of various small sections of the rural community and the establishing of a rather new type of factory worker.

Furthermore, if a temporary slump, such as occurred in the summer of 1930 in the machine-shop industry, causes factory employment to fail, the rural commuter is in reach of occasional employment, if only intermittent. He lives in the country and is a neighbor to farmers who are able to employ extra help at frequent intervals. Road work also offers another opportunity for temporary employment. Since the rural commuter is well known in the neighborhood, he usually has first chance on whatever rural employment there is and will naturally receive it before any "floating labor" gets it.

It has been said, "No one can starve on a farm." The employee living in the company tenement house in Windsor who finds himself temporarily out of work may well wonder where the next meal for his family is coming from. Even though he is no farmer in the strict sense of the word, the rural commuter finds no problem like this facing him at such a time. The cow will give milk, the hens lay eggs, the vegetable cellar yield many bags of potatoes, and the pig can be "dressed off" for meat.

The future promises to be a continuation of the present major factors that have come from the past and have made the Windsor region a balanced community. In spite of the industrial invasion, farming has succeeded in maintaining itself; and there is no reason to expect a great gain in industry or that new shops will come. Agriculture will probably gain, especially milk production, as truck routes open areas now producing little. Increase in milk production requires no great immediate outlay. It means merely a recovery of what is at hand, as, for example, by improving present meadows and pastures and using present buildings.

The future of the region is bound up with the future of the roads that knit together its component parts. With an increasing demand from urban New England for milk and cream, the improvement of the roads for milk-gathering routes will gradually make the back country more accessible. Following the river valley in all likelihood there will tend to develop a "frontage" along a main trunk line of cement pavement—a ribbon of settlement connecting the formerly isolated village clusters.

THE BARTLETT EAST GREENLAND EXPEDITION

Captain Robert A. Bartlett and Junius Bird

THE JOURNEY BY CAPTAIN BARTLETT

FIG. 1—Route of the expedition from Iceland to the point of leaving Greenlandic waters. Scale 1:57,500,000.

ON August 4, 1930, I was standing among the Eskimo ruins on Clavering Island close by the spot where, over a century ago, Captain Clavering had his famous encounter—the only known meeting between a white man and living Eskimos of northeastern Greenland. It was a beautiful site that the old Eskimos had chosen for their winter homes. With a southern exposure they could see the first gleam of the sun upon its return and the last of its departing rays. Hunting grounds both on land and sea were at the door, and plenty of fresh running water. In the warm, sheltered nooks on the slopes flowers grew in profusion; butterflies and bumblebees added to the charm of the picture. As I stood there and looked about I could only ask again "Why did the Eskimos leave this place, and where did they go?" The site was typical enough but particularly fortunate in its circumstances, and there seemed no reason for the exodus of its former inhabitants. Explanation may never be forthcoming. "It must constantly be borne in mind," says Birket-Smith, "that in Greenland we are not only at the very outskirts of the inhabited, but frequently also of the inhabitable part of the globe. A trifling incident . . . may shift the balance, and a region which has formerly been inhabited may be laid waste."[1]

The northeastern coast of Greenland between Scoresby Sound and Cape Bismarck and beyond is dotted with the remains of deserted villages, and, even if we fail to discover the reason for their abandonment, we can learn from archeological study of the sites much of the former life of their inhabitants and perhaps something of their migrations. This was the main objective of the Bartlett East Greenland Expedition, made under the auspices of the Museum of the American Indian, Heye Foundation, and the first American expedition of this

[1] Kaj Birket-Smith: The Greenlanders of the Present Day, in "Greenland" (3 vols., Copenhagen and London, 1928), Vol. 2, pp. 1–207; reference on p. 17.

nature to the northeast coast of Greenland. The Danish authorities, to whom thanks for the permits for exploration are here made, had stipulated that all archeological work should be done north of Scoresby Sound. The particular region selected, between the 74th and 75th parallels, though it had been visited by several expeditions was less known archeologically than the coast both north and south.[2]

The expedition sailed from New York on June 5, 1930, on the *Morrissey*, calling at Brigus, Newfoundland. The U. S. Bureau of Fisheries had loaned the expedition six thermometers, and on leaving Newfoundland we began taking surface-water temperatures. From Brigus to Reykjavik the run was without incident except that we had adverse winds. Noon observation on June 30 showed that we were north of Reykjavik, but fog hid the land. In fact, we could not see the famous Snæfellsjökull until we were well to the south of it, when the fog rolled off its snowy crown and revealed all its beauty. Here, almost on the Arctic Circle, we found a modern city in gala attire celebrating the tenth centennial of the founding of the Icelandic Parliament. A visit to the Meteorological Office to obtain reports of weather conditions for a month or two back and ice conditions around Jan Mayen and Scoresby Sound gave us encouraging news. All indications pointed to an early and open season and excellent prospects of reaching our objective.[3]

From the time of leaving Reykjavik (July 2) we encountered a lot of fog: we were seldom able to observe the sun, and the thermometer was used to good advantage. By its constant use we kept clear of ice till the latitude of Shannon Island was reached. Here around noon of July 9 we made the ice, light and scattered in a north-northwest direction. The next morning found us in heavy close-packed ice and in dense fog, which lifted in the evening to disclose the tops of high mountains. The 11th gave us fog again and heavy but open ice. At 3.30 p. m. coast water was reached and clear air. We tied to fast ice about two miles north of Bass Rock. Bird, Manley, and Bruun went on shore to investigate. They returned with the information that Danish hunters from Germania Harbor had been there a week or two before, as they learned from records left in the huts erected by the Baldwin-Ziegler Relief Expedition in 1901. The huts are well taken care of, and many of the original stores are still intact and in good condition.

On the 12th we steamed over to Shannon Island and tied onto fast ice about nine miles from Cape David Gray. Bird and Bruun went on shore to excavate.

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[2] Cf. Therkel Mathiassen: The Archaeological Collection of the Cambridge East Greenland Expedition 1926, *Meddelelser om Grønland*, Vol. 74, 1930, pp. 137–166; see pp. 140–141.

[3] The Danish Meteorological Institute's annual report on the "State of the Ice in the Arctic Seas" notes that the ice belt along the east coast of Greenland in July, 1930, was about 90 miles narrower than usual.

FIG. 2

FIG. 3

FIG. 2—Northern coast of Hudson Land as seen from the anchorage at the southwestern tip of Clavering Island (compare the map, Fig. 4 and the views, Figs. 5, 7, and 8).
FIG. 3—Eastern shore of Great Koldewey Island, approximately latitude 76° 30′ N.

The days now were filled with brilliant sunshine, the nights, if such they could be called, as well; but in a line outside from the southern end of Shannon Island to Bass Rock the fog bank lay like a smoke screen. Narwhal were plentiful in the waters; on land were musk oxen, bernicle geese, Arctic hare, wolves, and shore birds. The ice close to land was much broken up and disintegrated by running water from the melting snow on shore. On the 21st we steamed southward, keeping as close as we dared to the belt of fast ice that parallels the eastern shores of Little Pendulum and Sabine islands at this season. In Germania Harbor, Griper Roads, we saw the steamer *Godthaab*, with Captain Riis Carstensen, commander, and Dr. Lauge Koch on board. The former I had known as executive officer on the Danish patrol boat *Islands Falk* and looked to him for information on ice, game, good harbors, and Eskimo ruins. On shore here is a trapper station, headquarters of all Danish posts from Shannon Island to Scoresby Sound. Two of the young trappers accompanied us on our return to Shannon Island. Back at Cape David Gray we found the archeological party having so much success that we left them there while we made an excursion northward in search of zoölogical specimens. Among other things we wanted to get a musk ox calf, and we also wanted a walrus and bear group for the Philadelphia Academy of Sciences. Freeden Bay should have been a great place for walrus, but they may have been driven away by narwhal. We left the northern tip of Shannon Island, Cape Borgen, on our inside quarter with the ice about four miles wide. Many floes and bergs were frozen in to build one chaotic field of broken-up ice—ridge upon ridge of it piled high during the fall gales. What a place for a ship to end her days!

The weather was clear: the sun swinging round in the cloudless sky shone warm and bright on water, land, and ice. I imagine it was so warm that the polar bear became lazy and did not travel about. At all events none was seen. Past Koldewey Island we continued in brilliant sunshine to Cape Bismarck. We were strongly tempted to continue northward, indications showing a free and open sea to north and east, but in consideration of our party on Shannon Island it seemed wisest to return.

Having picked up the archeological party I decided to make for Clavering. The ice around the island was moving out, and I knew that I should find there a good safe anchorage and harbor. We passed close by Walrus Island and, rounding Cape Borlase Warren with its low foreshore and many stranded bergs off the point, crossed the mouth of Tiroler Fjord to skirt the southern shores of Clavering and drop anchor opposite Jordanhill. The whaleboat made an excursion up Loch Fyne, but the country proved uninteresting, and we steamed out and along the south side of Clavering to drop Bird at Cape Mary. Steaming into Tiroler Fjord we again met the *Godthaab*

FIG. 2—Northern coast of Hudson Land as seen from the anchorage at the southwestern tip of Clavering Island (compare the map, Fig. 4 and the views, Figs. 5, 7, and 8).
FIG. 3—Eastern shore of Great Koldewey Island, approximately latitude 76° 30′ N.

and learned that the ruins we were seeking were on the southeast side of Clavering and that there we could get our group of musk oxen as well. We found the ruins at the place visited by Captain Clavering in 1823. Excavation was started immediately and kept up for a week. Meanwhile a hunting party from the expedition circumnavigated the island, encountering bad weather—rain and fog—the entire circuit.

FIG. 4—Map of the part of the eastern coast of Greenland visited by the expedition (compare Fig. 1). Scale approximately 1 : 4,000,000.

On August 10 the *Morrissey* was headed southward for the return, following the loose ice. Off the Liverpool Coast not much ice was encountered; but there was heavy fog, and we decided not to go into Scoresby Sound. We wished to keep our course as close to the ice as possible in hope of getting a bear, but continuous fog kept us more often in open water. In my track chart the readings of the surface-water temperature gave me a fairly good idea of the width of the belt of ice. A stop was made at Angmagssalik, reached on the 27th, where we had news of the *Quest* Expedition. Brigus was reached on September 9.

ARCHEOLOGY BY JUNIUS BIRD

The region around Cape David Gray, the southwestern extremity of Shannon Island, has always been at the edge of the field of operations of the various expeditions that have examined the eastern part of the island and the coast north and south. Clavering, in 1823, was within fifteen miles and located it on his map. Members of the Second German North Polar Expedition, 1869–1870, crossed Shannon Island on foot, climbed and measured the Tellplatte, but did not go beyond. Their collection of archeological material was mainly surface and grave finds from Sabine and Clavering islands to the south. The Nathorst Expedition, 1899, in search of Andrée, visited Pendulum, Walrus, and Sabine islands, then sailed south to Franz Josef Fiord, exploring and mapping new territory. They located many house ruins and gathered a number of objects from the surface. In 1901 a Swedish expedition

FIG. 5—Looking westward from Eskimo Bay, southwestern Clavering Island. The mountains that show through the clouds lie just west of the entrance to Loch Fyne Fjord, discovered by Clavering in 1823.

under Kolthoff did zoölogical collecting in Franz Josef Fiord. The *Belgica*, in 1905, under the Duke of Orleans, explored some of the coast north of Shannon Island, securing zoölogical and botanical specimens.

The archeological collecting of the Danmark Expedition, 1906–1908, was the most extensive ever undertaken along the northeast coast and was most intensive in the Cape Bismarck district, a hundred miles north of Shannon Island. In the course of their mapping work Cape David Gray was visited by sledge but at a time when the light was poor. Four house ruins were reported. The Alabama Expedition, 1909–1912, which had winter quarters on the east side of Shannon Island, was a search expedition for Mylius Erichsen and his companions, leader and members of the Danmark Expedition, who perished on a journey to the northeastern extremity of the coast in 1907. The Cambridge Expedition, 1926, while surveying from Little Pendulum Island to Davy Sound, gathered some archeological ma-

FIG. 6—East coast of Greenland about latitude 66°. This is on the south side of Smalsund glacier and shows the state of the ice in August, 1930.

FIG. 7—The coast east of Loch Fyne, Homes Foreland, as seen from the southwestern tip of Clavering Island.

terial, which has been described by Mathiassen.[4] In 1926 and 1927 Lauge Koch made reconnaissance geological and economic surveys in the region between Scoresby Sound and Denmark Harbor and again visited the region in 1929 and 1930. A Norwegian government expedition in the *Veslekari* visited the region between King Oscar's Fiord and Pendulum Island in 1929.[5] In all cases the archeological work has been secondary or incidental to some other objective.

Mention must also be made of the visits of hunting and sealing vessels, though, unfortunately, little is known of their observations. From 1889 to 1921 at least eighty-two Norwegian ships reached the east coast.[6] At present a number of Danish and Norwegian trappers are wintering at various places as far north as latitude 76°.

RUINS ON SHANNON ISLAND

Our first excavations were carried out on the southern side of Shannon Island at Cape David Gray. Altogether twenty-one houses were found along the shore at four places in this neighborhood. Seven of the houses were so dilapidated as to be scarcely discernible until one stood within a few feet of their walls. Their condition was such as to suggest that they represent the oldest type reported by Thostrup as occurring in the Cape Bismarck district and northward.[7] Of these houses only the first two found were excavated. They are located at the south side of the Tellplatte, where a small trappers' shelter now stands.

The ground in front of these houses had thawed to a depth of 18 inches; but, as the interiors were buried beneath 12 to 40 inches of gravel and clay, the occupational débris was well frozen. Fifteen days after uncovering began there was still a little unthawed material between the stones of the bed platform.

[4] Matthiassen, *op. cit.* See also the preliminary account of the archeology work by D. McI. Johnson, *Geogr. Journ.*, Vol. 70, 1927, pp. 254–260.

[5] See note in the Geographical Record.

[6] Gunnar Isachsen: Norske fangstmænds færder til Grønland, *Norske Geogr. Selskabs Aarbok*, Vol. 31–32, 1919–1921, Christiana, 1922; pp. 201–261.

[7] C. B. Thostrup: Ethnographic Description of the Eskimo Settlements and Stone Remains in Northeast Greenland [results of the Danmark Expedition], *Meddelelser om Grønland*, Vol. 44, 1917, pp. 183–355.

FIG. 8—The coast of Hudson Land. Mountains west of the entrance to Loch Fyne Fjord as seen from the southwestern tip of Clavering Island. Cape Stosch in the left foreground.

To the westward of the Tellplatte within a mile of the first site, on a low, flat point were seven winter houses, twelve graves, tent rings, and other stone remains. All efforts were directed toward a thorough examination of the winter houses at this second site. The one nearest the shore and 450 feet south of the rest, which were grouped side by side, is undoubtedly the one reported by members of the Danmark Expedition, in 1907, as No. 758.[8] Here we tried the experiment of using calcium chloride in thawing out the frozen débris. The results were satisfactory enough to justify its use for similar work where the problem of transportation is not too great. The normal thaw inside the houses amounted, on clear days, to an average of one inch in twenty-four hours. If the sun could reach the material for that period, as much as three inches melted, but unless this layer was removed the effect of the sun practically ceased. Calcium chloride doubled this rate and enabled the work to be carried on when the sun was of little help. It proved especially useful inside the still covered passageways of the better preserved houses where there were often thick layers of clear ice. The only other way these passages can be cleared is by tearing them apart and partially destroying the houses, and this we tried to avoid as much as possible. Wherever there is clear ice the salt works very rapidly without injuring objects imbedded in it.

The seven houses of the second site had not been occupied simultaneously, at least not in the last period of occupation. Two of them had been torn apart to be used in the construction or alteration of the others. The tendency in later times seems to have been toward the construction of smaller houses. In three cases walls had been built inside the original houses, considerably reducing their interior dimensions.

An examination of the refuse outside the entrances showed a thin though extensive scattering of material, nowhere thick enough to form an actual layer. Bones were found from the surface to a depth of four inches. Objects found at such shallow depths suffer materially from the annual thawing and freezing, and the more perishable sort are

[8] *Ibid.*, pp. 333–335.

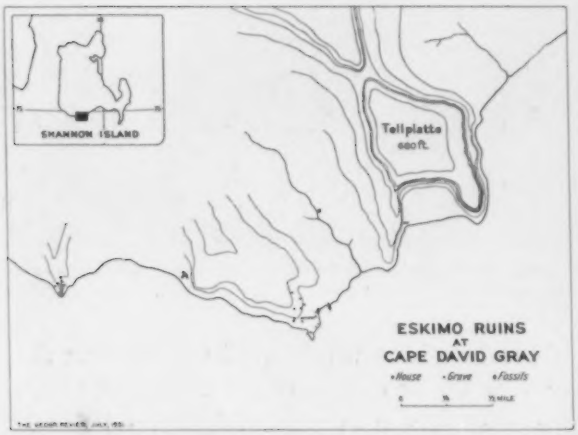

FIG. 9—Location of Eskimo ruins, Cape David Gray, Shannon Island. Compare Figures 11–13.

missing. Inside the houses less thawing occurs, and the specimens found are in better condition.

Naturally anyone doing archeological work in northeast Greenland is anxious to strike a location where the last inhabitants have perished. So, when the top of a human cranium appeared, as the ice in the passageway of one of the houses melted, our hopes mounted. The jawbone soon appeared and with it an unbroken thigh bone of a young bear, both with bits of pellicle attached. That was all: no other human bones were found.

Inside the house were many fine things. On the bed platform, resting on the remains of a bear's skin, was half of a well preserved double-bladed kayak paddle with a 46-inch blade, 3 inches wide, a large drip ring, and a mid-section over 26 inches long; the paddle must have measured more than ten feet originally. Beside it on the platform were three iron-tipped drills, a fire drill and hearth, freshly cut and ready for use, a large lump of iron pyrites, a foreshaft for an ice-hunting harpoon, a variety of other objects, and more than a hundred small ivory carvings of birds, seals, and miniatures of various things. The two lamp stands were empty, but on the floor by one of them lay a crude lamp made by cementing two rib bones to a naturally hollow stone. The outfit in the house would indicate that there were survivors who made off with the most necessary items of their equipment.

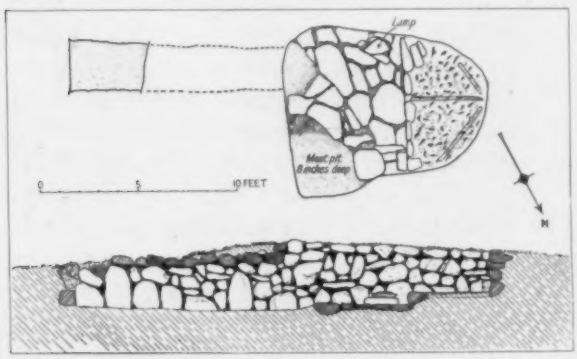

FIG. 10—Plan and elevation of a house site (7B) excavated at Cape David Gray, Shannon Island.

A similar find had been made at Snenaes, latitude 76° 49′ and longitude 19° 21′, by

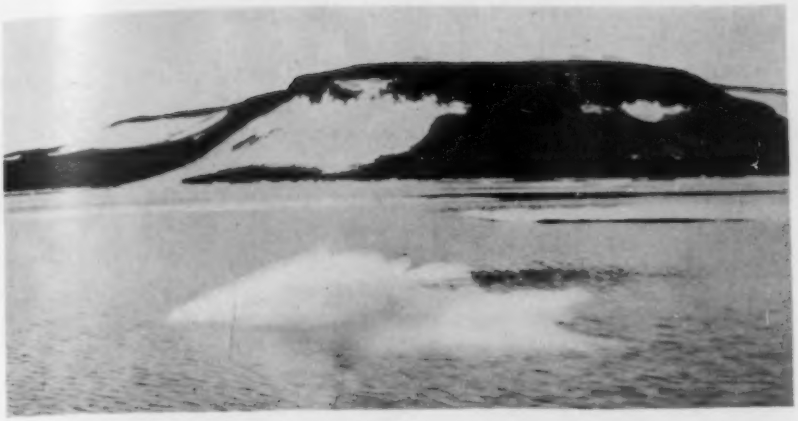

FIG. 11

FIG. 12

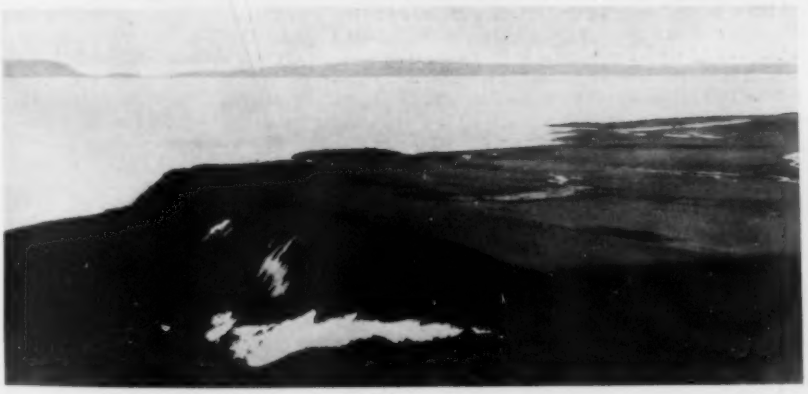

FIG. 13

FIG. 11—Southeastern side of the Tellplatte as seen on July 30, 1930; Cape David Gray.

FIG. 12—House site A1, one of the apparently "ancient" houses found on Shannon Island, which may correspond with what Thostrup considered the first occupation on the northeast coast.

FIG. 13—View a little west of south from the top of the Tellplatte. On the point at the right edge of the picture are seven Eskimo houses excavated by the expedition.

Thostrup of the Danmark Expedition.[9] There human remains were found in a house with objects that would not ordinarily have been overlooked by people moving away, yet by themselves they did not make up a complete outfit. The survivors seem to have left in haste.

The skull found by us has been examined by Dr. Bruno Oetteking, who says it is apparently that of a woman about 45 years of age. The

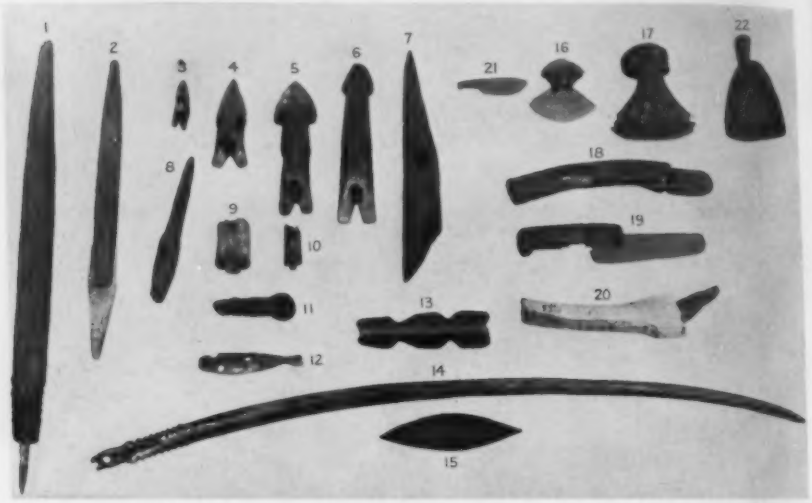

FIG. 14—Typical implements, about 1/6 natural size: 1, large drill with heavy iron point found in house containing human remains, Shannon Island; 2, drill with slate point from cache of grave goods, Shannon Island; 3, harpoon point which fits the foreshaft No. 8; 4, Thomsen's Type 1, without inserted blade caribou antler; 5, Thomsen's Type 1, with inserted iron blade, Shannon Island; 6, Thomsen's Type 1, without inserted blade but with point carved to the shape of a blade, Clavering Island; 7, whaling harpoon point of narwhal tusk, Clavering Island; 8, movable forepiece or foreshaft; 9 and 10, butts of movable forepieces; 11, small stone scoop or dipper, Clavering Island; 12, bone decoration of the type used extensively at Angmagssalik, found between the wall stones of recently occupied house on Shannon Island; 13, winged needlecase without ornamentation in grave on Clavering Island; 14, meat fork (?) from the same grave as 13; 15, model umiak; 16, child's *ulo* slate blade, Shannon Island; 17, *ulo*, wooden handle, steel blade, last occupation of Clavering Island; 18, man's knife, antler handle, iron blade, late occupation, Clavering Island; 19, man's knife, wooden handle, slate blade baleen lashings, late occupation, Clavering Island; 20, man's knife, antler handle, stone blade, surface find near grave, Clavering Island; 21, slate blade for man's knife, old house, Shannon Island; 22, wooden scoop, Shannon Island.

presence of the unbroken bear's thigh bone, which must have contained considerable marrow, would indicate death from disease rather than starvation. Moreover, this region has been reported as favorable for hunting. Open water has been seen throughout the year in Freeden Bay, just to the east. The water is shoal, and the bottom supports an abundance of marine life. If seals were to be found anywhere along the coast they should be found here. The abandoning of dead and dying in the houses has been reported from different locations in the Eskimo territory. Hence this cannot be regarded as unusual or be positively connected with the ultimate disappearance of these people.

[9] *Ibid.*, pp. 276–279.

Among other things of interest found at this site is a large harpoon point of Thomsen's Type 1 but with a big inserted blade of iron.[10] It was found in the occupational débris of a house above which, and separated from it, was a small cache pit, built after the house had been vacated, indicating that the house had been abandoned in the normal course of events and not hurriedly, like the house with the skeletal

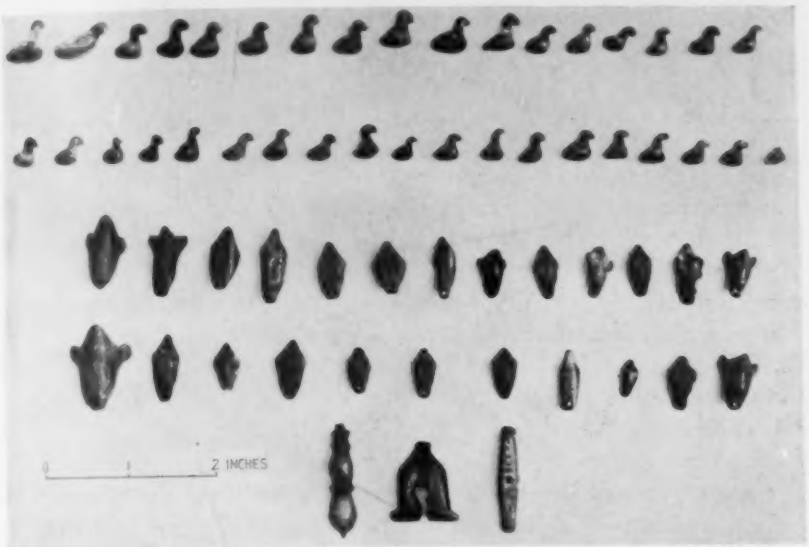

FIG. 15—Sixty bird and seal carvings found in the house containing human remains on Shannon Island. The three objects at the bottom are also from Shannon Island: the one at the left and the one in the middle may be pendants; the one at the right is probably a small toggle and shows the only type of decoration found—straight rows of dots.

remains. If iron had been particularly scarce at that time such a fine point would hardly have been mislaid. Most of the harpoon points found here in the last houses occupied were of this pattern, Thomsen's Type 1, but with inserted blades. Only one with an iron blade was found, though there are indications that others were so fitted. Iron pyrites seems to have been quite common, occurring in six of the nine houses examined, the fragments ranging in size from minute particles to lumps weighing more than five pounds.

Only two chipped flint objects[11] were found on Shannon Island, although there were more than a hundred and fifty flint chips and flakes some of which were undoubtedly utilized. Two examples of the use of such flakes were unearthed: one, a graving or carving tool for working ivory; and the other a very small piece used as a drill tip.

The grave finds constitute a small portion of the total. In one

[10] Thomas Thomsen: Implements and Artefacts of the Northeast Greenlanders [results of the Danmark Expedition], *Meddelelser om Grønland*, Vol. 44, 1917, pp. 357–496.

[11] The term flint, as used in this article, indicates all pieces of siliceous material, some of which resemble flint but have not been positively identified as such.

FIG. 16—Model sledge for child. Found in a house ruin on Cape David Gray, Shannon Island.

case what appeared to be a grave, similar in size and general shape to the graves that had been examined, was opened and found to contain a hunting outfit instead of a skeleton. The cache was well built and was large enough inside to hold a body, but instead was a splendid bow, complete save for the sinew backing, eight arrows, most of which were badly decayed, a drill with slate bit, and a section of harpoon shaft. As there was no other grave near by, the only explanation seems to be that the objects were placed there for some man who was drowned or otherwise lost.

A search farther west along the coast of Shannon Island resulted in the discovery of five more of the apparently old houses referred to before. It is doubtful if they could be recognized by anyone traveling alongshore by sledge or boat. They had not been disturbed in any way; nor had the seven better preserved houses that were found on the next point to the west.

At this last site two objects of interest rested on the surface of the ground. One, a weather-beaten stick about three feet long, bore the inscription: "P. S. BRANDAL AA 1900" and on the opposite side: "AALESUND." This lay well out of reach of the water and ice and

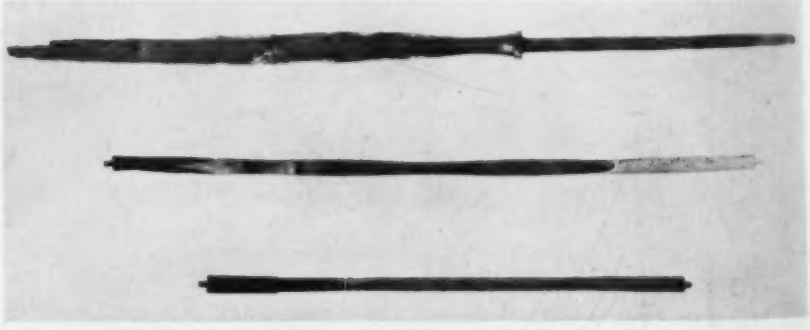

FIG. 17—Paddle (above) and bows (below) from Shannon Island. The upper of the two bows resembles closely the one in the Danish National Museum from west Greenland; but it is longer, measuring 61½ inches from tip to tip, and has wooden strengthening pieces, instead of bone, at the bends. The lower bow, found in the entrance tunnel to one of the houses, is 45½ inches long.

could only have been carried to where it was found by human agency. The second object was a throwing board of a previously unreported type. That the board is not a freak specimen is shown by the occurrence of a child's model at a site sixty miles to the south.

A comparison of the material from the apparently old houses

FIG. 18—The site of the house ruins on Eskimo Bay, Clavering Island. The remains of 23 houses are in the strip of turf just above the beach.

examined with that from the unquestionably late ones shows no such marked difference as might be expected. The lack of iron-tipped tools and the relative abundance of flint chips in the poorly preserved houses may be accidental. The harpoon points from the "older" houses were all of the first two types described by Thomsen, with none of the Type 1 variant with inserted blade found in the later houses. Perhaps these houses are not in fact to be grouped with those reported from farther north. Undoubtedly their situation at the edge of a slope had a great deal to do with their poor state of preservation. It can only be repeated that, had they been in any worse condition, they could not have been seen.

After eighteen days ashore on Shannon Island we departed with regrets at having to leave so many houses untouched, so much still to be done.

ESKIMO REMAINS ON CLAVERING ISLAND

Following Captain Riis Carstensen's instructions we proceeded to the ruins on Eskimo Bay on the southern shores of Clavering Island. As one approaches the village site by boat the most prominent feature of the surrounding country is a large fan of gravel and boulders, along one edge of which runs a small stream. East of this is a sandy

beach 150 yards long, above which is a sloping strip of turf. Here are the remains of twenty-three houses.

Most of the houses are of turf, good building stones being scarce in the neighborhood. Only three, with walls completely of stone, are in fair preservation. In the rest stones are utilized to some extent in

FIG. 19—Remains of a turf-and-stone house on Clavering Island before excavation. A fragment of bottle indicates that this was one of the latest occupied houses. The use of turf instead of stone for the walls explains the poor state of preservation.

the walls but mainly for floor paving and to form the forward edge of the sleeping platform and lamp stands. The outlines of the turf houses, where they could be determined, resemble the largest houses on Shannon Island.

There was no evidence of work by previous expeditions though the *Germania* expedition in 1870 reported having dug in the interior of one of the stone houses.[12] The wall stones of the house, which corresponds to their description of the one they examined, had been disturbed, but that may have been done by visiting trappers who have a shelter here.

Twelve houses were examined but in several cases were not completely excavated. Little frost was encountered, particularly in the turf houses. This explains the poor state of preservation of most of the objects found here. Portions of the refuse in the houses had been saturated with oil and blood and were harder to break up and examine than if they had been frozen. Outside the houses only enough digging was done to determine the thickness and extent of the refuse there.

[12] The description of this site given by Dr. Pansch in the report of the German Expedition is not very clear (Die zweite Deutsche Nordpolarfahrt in den Jahren 1869 und 1870 unter Führung des Kapitän Karl Koldewey, Leipzig, 1874). Certain features of the site lying to the east seem to have been confused with it.

Bones were found three to five inches down over the whole of the area. Enough material should be found here to justify the time necessary for excavation.

FIG. 20—One of the stone houses on Clavering Island as it was when found. One shovel is in the center of the house; the other marks the outer end of the entrance tunnel. Compare Figure 21.

In one turf house and in one of the well preserved stone houses two small pieces of bottle glass from different bottles were found, probably relics of Sir Edward Sabine's expedition, of which Clavering was sailing master. The *Germania* Expedition failed to find any remains of a wooden observatory erected by Sabine near Eskimo house ruins on Sabine Island, and it seems probable that it was torn apart by Eskimos for the wood and nails. They may have picked up the bottles there. Iron was found in only one of the stone houses—the head of a hand-made, twenty-penny spike. Flint chips were most abundant in the turf houses; but many were found associated with the fragments of glass, showing a late use for such material. There were only three fragments of flaked flint objects, however.

Koldewey remarked on the absence of graves in the vicinity, and it was some time before they were found. Of the seven seen, six are built on the wash in the center of the valley and are invisible from the houses. Only three were undisturbed, and in these the skeletons and grave goods were poorly preserved.

FIG. 21—The house of Figure 20 after being cleared. The pick rests on the center of the bed platform, the forward edge of which is marked by the six-foot rule. The whisk broom is in a shallow pit where meat and blubber were placed. The paved area is the floor space. The entrance was at the left.

The roof of one grave was supported by a sledge runner, 59 inches long, 7 high, and 1¼ thick. Other objects include a winged needle-case, a meat fork or snow probe 19⅝ inches long, and a knife with a large unworked flint flake for a blade.

A mile or more east of Eskimo Bay, where the next small river empties, are six more houses, four of which were excavated. Two of them are built side by side and are surrounded by a low wall of turf. Each has a separate entrance, and they are not connected in any way. Again, new walls had been built inside older ones, reducing the size of the interiors. In one of these, three more pieces of bottle glass were found and, associated with them, part of a finely chipped flint knife as well as an *ulo* with iron blade. Two iron-bladed whittling knives occurred in the adjoining house along with a broken example of the late-type movable forepiece, the butt ending with a flat surface and small central projection. This type has been found in the vicinity of Scoresby Sound and in one instance a section of one made over into a sledge buckle, at latitude 76° 56′ N.

Of the three graves here, two had collapsed; and the third had been opened, but the skeleton had not been disturbed. The roof of this last grave was supported by large pieces of driftwood and a broken sledge crossbar. Inside the grave area were thousands of empty fly puparia and small pieces of clothing or wrappings of seal and caribou skin. No grave goods were found, but these may have been taken by whoever opened the grave.

The west side of Eskimo Bay is formed by a rocky promontory, beyond which to the westward is a long strip of sandy beach. Near the middle of this beach a small stream empties. Just west of the stream, 170 feet from the shore, are three houses and a little farther on three more, all in varying stages of preservation.

The work of clearing the two most recent houses was started, but it was thoroughly completed only in one of them. The other appeared to be another case of remodeling to reduce the size. Much of the refuse in this house was frozen, and we had to leave before it was completely thawed.

Among the finds from these houses was a whaling harpoon point, 7¾ inches long, circular in cross section, without an inserted blade, and very simply made from a section of narwhal tusk. Of the four other harpoon points, one was Thomsen's Type 1 but with inserted blade. One more broken example of the late-type foreshaft with a flat butt and small central peg came to light.

The archeological work ended August 10 at the last site referred to. More than a thousand specimens were collected, not including about eight hundred flint flakes some of which must have been utilized, without further working, as cutting tools.

HEIGHT LIMITS OF MOUNTAIN ECONOMIES

A PRELIMINARY SURVEY OF CONTRIBUTING FACTORS

Roderick Peattie

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THERE is a question whether or not we should use the term zones in mountain geography. True, there are cases where zones are relatively distinct. On Mt. Etna, for instance, making allowances for the interruptions caused by lava flows, zones exist with a certain definitude. But ordinarily matters are not so simple. In mountain ranges and in mountain systems wild life and human economies are not well zoned. Krebs in his great study of the Eastern Alps finds it necessary to abandon the use of zones.[1] He finds wheat and corn, for example, growing in spots climatically favored, and the vine exists only on those slopes exposed to the föhn. The reason is that mountain geography involves dramatically rapid changes of the conditioning factors. In a regional study a zone is at best an average which seldom occurs in reality, and the more detailed the analysis the less apparent is the zone. The virtue of zone descriptions is to illustrate some broad control, such as latitude.

Culture Limits on Mount Canigou

By way of illustrating the complexity of factors involved in a consideration of height limits of culture let us take an illustration from Sorre's study of the eastern Pyrenees. Mt. Canigou is a relatively isolated peak within sight of the Mediterranean. Its summit is 2785 meters in elevation. Sorre[2] would have three climatic levels on the Mediterranean flank, each with characteristic vegetation. He points out that up to 700 meters vegetation—winter cereals, the olive, and the evergreen oak—is organized against the loss of water. From 700 to 1700 meters there is an abundance of well distributed rain and an increased rigor of winter. Here are hayfields, rye, conifers, and beech trees. Above is a forest and pasture area, inhabited only in summer, where there are lower temperatures, greater precipitation, and significant snow cover. But there are no zones. Too many factors work towards irregularity.

The eastern flank supports the orange, oleander, and olive to

[1] Norbert Krebs: Die Ostalpen und das heutige Österreich, Stuttgart, 1928. These two volumes contain an exhaustive bibliography of German references on mountain geography.

[2] Maximilien Sorre: Les Pyrénées méditerranéennes: Étude de géographie biologique, Paris, 1913.

FIG. 1

FIG. 2

FIG. 3

FIG. 1—The blast of air that precedes the avalanche (foreground) has destroyed the trees on this slope.

FIG. 2—The rectangular white patches are grainfields, situated on the ubac because it is more nearly level.

FIG. 3—A mayen alp devoted to hay culture and in a lesser extent to fields. Central French Pyrenees.

500 meters. Their limits are functions at once of altitude and distance from the Mediterranean. The cork oak reaches 780 meters on the eastern flank but, except for rare cases, is lacking elsewhere. Cork is confined to siliceous ground. Here we have an economic adjustment to soils. Human interference must always be taken into account. The olive, which is a delicate indicator of Mediterranean climate, is found on the sunny south slope at 748 meters and in a valley on the north at 875 meters. The discrepancy is due to the fact that the northern valley has a topography that makes it peculiarly open to Mediterranean influences. Local topography must always be dealt with in mountain geography. Lastly, the forest limit on the peak itself is surprisingly lower by several hundred meters on the south slope. The reason is that an indraft of air combined with a strong sea breeze causes excessive cloud at the head of the valley on that flank and significantly lowers summer temperatures in an altitude where temperatures are critical.[3]

[3] Roderick Peattie: Nuages en bannière, *Rev. de Géogr. Alpine*, Vol. 17, 1929, pp. 329–335.

Altitude, Mass, and Air Temperature

The relations of altitude to temperature need little demonstration. Of the various modifications of the vertical temperature gradient the most important is that due to mass of mountain. Other things being equal, which, however, they seldom are, the greater the mass of the mountain the greater the mean temperature at a given elevation. More significant is the fact that the greater the mass normally the longer the growing season. The most casual traveler among mountains cannot fail to notice the higher limits of agriculture on plateaus than on peaked mountains. Thus rye cultivation is notably higher on the plateau of the Cerdagne in the French Pyrenees than on the flanks of the mountains of the near-by Conflent. Topography and accessibility might be thought to be hindrances to rye growing in the latter region were it not that rye is grown on tiny fields in almost inaccessible spots. Forest limits are higher in the massive Alps than in the Fore-Alps of France.[4] Imhof points to

[4] Félix Lenoble: La légende du déboisement des Alpes, *Rev. de Géogr. Alpine*, Vol. 11, 1923, pp. 5–116; reference on pp. 28–29 and 48–49.

Fig. 4

Fig. 5

Fig. 6

Fig. 4—The ubac is grass, and the adret is forest or barren because of slope and soil. Vanois, French Alps.

Fig. 5—A *gave* of the Central French Pyrenees showing fields climbing up the alluvial cones.

Fig. 6—The village of Val d'Isère high in the pastora zone maintains a few tiny fields upon the adret slope.

the same thing for Swiss forests.[5] Marek puts this fact in map form.[6] A neat illustration is given by Levainville, comparing the valley of Barcelonnette (Ubaye River) in the French Alps with stations of comparable altitude embedded in adjacent but greater mountain masses.[7] Mass of mountain can be worked out quantitatively; a formula for its computation has been given by Anfossi.[8]

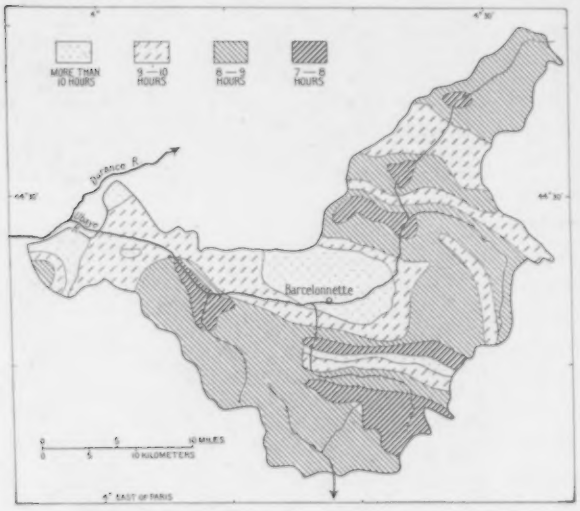

FIG. 7—Average daily hours of sunlight in the valley of Barcelonnette. Zoning is impossible in such an instance. (After Fig. 1 of J. Levainville's work cited in footnote 7.)

There are many other factors that enter into the question. Greater mass means ordinarily gentler slope. Roads mount such slopes easily. Fields and villages are thus found at higher levels. Because of greater snowfall, character of soil, and degree of slope, there may be excessive ground water which forces the cereal lines valleyward. Cereal lines are therefore not in every case higher on plateau slopes than on the flanks of peaks.

PRECIPITATION

The existence of a maximum precipitation on mountains is well known. Hann puts the maximum for the Alps at 2000 meters, and this is the generally accepted height. Bénévent, subdividing the northern section of the French Alps into the Fore-Alps, Central Massifs, and Intra-Alpine Zone, placed the optimum respectively at 2000 meters, 2500 meters, and 2500 to 3000 meters.[9] Joseph Vallot, who established the observatory on Mont Blanc, makes the claim that the summit of Mont Blanc has less precipitation than

[5] Eduard Imhof: Die Waldgrenze in der Schweiz, *Beiträge zur Geophysik: Zeitschr. für physikalische Erdkunde*, Vol. 4, 1900, pp. 241–330.

[6] Richard Marek: Waldgrenzstudien in den österreichischen Alpen, *Petermanns Mitt. Ergänzungsheft No. 168*, 1910. Map on scale of 1 : 1,000,000.

[7] Jacques Levainville: La Vallée de Barcelonnette, *Ann. de Géogr.*, Vol. 16, 1907, pp. 223–244.

[8] Giovanni Anfossi: Volumétrie de la Corse, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 6, 1918, pp. 27–69.

[9] Ernest Bénévent: Le climat des Alpes françaises; *Mémorial de l'Office Natl. Météorol. de France. No. 14*, Paris, 1926, p. 264. This excellent work has a fine bibliography.

Montpellier, a town on the Mediterranean coast of France.[10] The maximum height in the Pyrenees is not definitely ascertained, and one authority believes it to be higher than the usually accepted figure of 2000 meters.[11] My experience in Andorra in the heart of the range is that the summit plateau at 2000 to 2600 meters is relatively dry as compared with the slopes. The relative aridity is a definite barrier to beech trees and rye at high levels.

The greater the mass of the mountain the higher the level of the clouds. This then may be another reason for the greater height of cultivation on massive mountains. The cloud zone on Mont Blanc is said to be at 3000 meters and in the Prealps at 2000 meters. But here we are again involving questions of exposure and topography. The greater the cloudiness of a zone the less the evaporation. Summits of exposed mountains are notorious for their high evaporation regardless of height. Summits of even moderately low mountains are commonly barren of trees other than elfinwood, largely because of evaporation due to high winds. De Martonne, after considering matters of mass of mountain, winds, and the economic demands for pasture, finds tree limits in the Alps and, particularly, in the Carpathians not to extend beyond the zone of greatest rainfall.[12] Precipitation and evaporation then may control tree limits as well as altitude modifications of temperature.

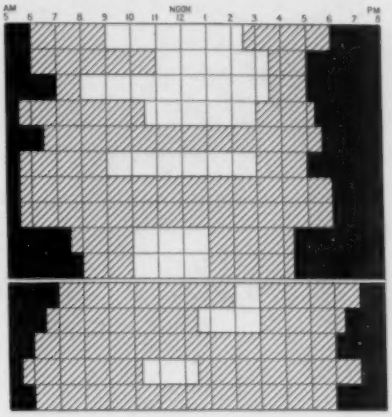

FIG. 8—Hours in which stations in the Valgaudemar (tributary valley of the Drac) receive direct sunlight. The data are for ten villages on the adret (above) and five on the ubac (below). The hours between the black area represent sunlight on the longest day of the year. The unshaded area represents sunlight on the shortest day of the year. (After Fig. 4 in A. Gibert: Le Valgaudemar, *Rev. de Géogr. Alpine*, Vol. 11, 1923, pp. 663–782.)

We lack properly equipped meteorological stations at high altitudes. Mention here is made of the excellent station on the Pic du Midi de Bigorre in the central French Pyrenees. The station (2859 m.) is one of the highest permanently inhabited points in Europe, but its location and the type of data collected make its records of more importance to the theoretical climatologist than to the anthropogeographer. Establishment of a "High Altitude Institute" on the Jungfrau, at an elevation of 3500 meters has recently been announced.

[10] Quoted by Charles Flahault: Les hauts sommets et la vie végétale, *La Montagne: Rev. du Club Alpin Français*, Vol. 1, 1904–1905, pp. 165–183; reference on p. 172.

[11] Henri Gaussen: Végétation de la moitié orientale des Pyrénées, Paris, 1926, pp. 85–88.

[12] Emmanuel de Martonne: La Valachie: Essai de monographie géographique, Paris, 1902, pp. 88–102.

In this conjunction one may raise the question of the effectiveness of mountain rain gauges in recording mountain rainfalls.[13] Much of the precipitation is from fog and is difficult to collect, especially when it condenses on trees and grasses. The evaporation in cloud is nil—often so for days at a time. The large streams that are derived from modest-sized drainage basins on mountain tops confirm the suspicion that the instrumental records are apt to be understatements. Again, the effectiveness of mountain precipitations for agriculture is increased because high mountains store their winter precipitation in the form of snow till the growing season brings melting temperatures.

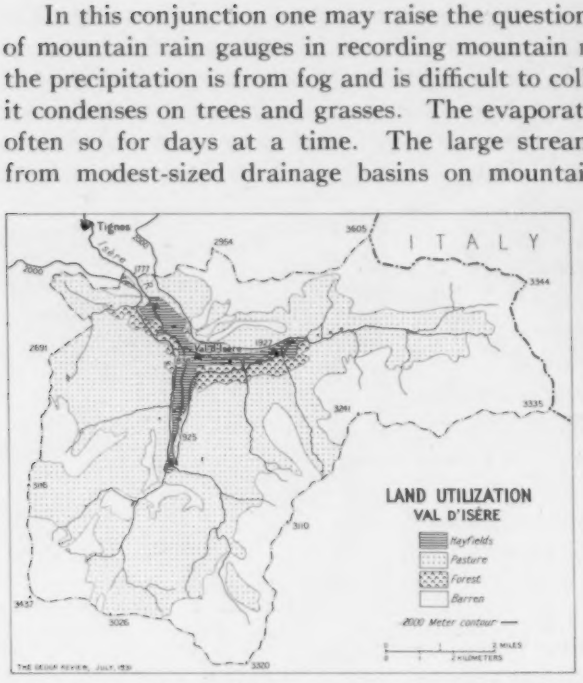

FIG. 9—Use of land in a high commune of the French Alps. There are a few fields of potatoes and rye too small to map in the hayfield region on the adret, or north of the stream. Much of the barren area is actually under ice. (Based on the Service Géographique de l'Armée 1 : 50,000 map, sheet xxxvi-33, 1911.)

Snow lines as limits to culture should be considered by months. The snow line is at any moment the balance of supply and wastage. For this reason the high intensity of spring insolation on favorably exposed alp lands, i. e. the high level slopes devoted largely to pasture, may give actually longer growing season than is found on valley bottoms. This is not so much a matter of higher air temperatures as of an early warming of the soil. Some day we shall talk of the growing season in terms of soil temperatures rather than air temperatures. Inversions of temperature are important. One of the most interesting references on inversions of temperature and perhaps the best presentation of data is that of Früh in his recent volume on the geography of Switzerland.[14]

Snow, mostly in shady exposures, may remain on the ground so long as locally to lower the culture lines to the thalweg. In any case snow lowers significantly the period of pasturage. In the valley of the Inn at 2500 meters there are only eight snow-free weeks. Permanent snow here begins at 3000 meters and of course restricts all

[13] Raoul Blanchard: Énormes précipitations dans le massif de la Chartreuse, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 7, 1919, pp. 717–720.

[14] Jakob Früh: Geographie der Schweiz, St. Gall, 1930, Vol. 1, pp. 267–271.

pasturing. Indeed, historical advances of ice and snow over the pastures have actually ruined considerable areas. In the French Alps there are many prairies that now are meager pastures but were of first importance before the advances of the ice at the close of the sixteenth century. It has been said that snow is a factor in forest limits, as in the Tirol, where at 2400 meters the duration of the snow cover is nine and a half months. The extent to which snow duration limits human habitation is well brought out by an interesting article by Mlle. Bigallet, who describes a winter in Haut-Vénéon, French Alps.[15] The importance of avalanches in lowering culture lines and limiting village sites may be discovered in a large number of regional studies (Fig. 1).[16]

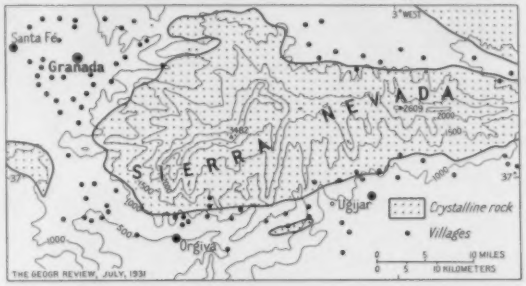

FIG. 10—Distribution of villages in the Sierra Nevada. The upper limit of village sites is not a matter of altitude but of bed rock with its attendant matters of relief, soil, and ground water. The shaded portion represents crystalline rock: surrounding rocks are sedimentaries. (From the geological map of the Sierra Nevada accompanying Excursion A 5, Fourteenth International Geological Congress, Madrid, 1926).

On the other hand, snow has its benefits. It protects winter grain, facilitates movement of hay from high fields, and aids in logging. Premature snows disturb the rhythm of nomadic life and cause unusual demands on lowland pastures and hay stored in granges. Bénévent has reduced the temperature of the French Alps to sea level and thus demonstrated the influence of snow on air temperatures.[17]

INSOLATION, ALTITUDE, AND GRADE OF SLOPE

Insolation increases with altitude when the air is clear. In computing annual values exception must be made for belts of habitual mountain clouds. Insolation must be thought of in terms of heat, light, and ultra-violet rays. In valleys that have exposed rock walls reflected heat and light may be of great significance. Lakes likewise reflect heat and light. As if by way of compensation for low air temperatures high-level valleys have high insolation values, resulting in higher soil and plant temperatures than the air temperatures would suggest. It is not true then that agricultural economies become

[15] Aimée Bigallet: La vie d'hiver dans le Haut-Vénéon, *Rev. de Géogr. Alpine*, Vol. 10, 1922, pp. 625–634.

[16] See for instance André Allix: Avalanches, *Geogr. Rev.*, Vol. 14, 1924, pp. 519–560. A French version, "Les avalanches," appears in the *Rev. de Géogr. Alpine*, Vol. 13, 1925, pp. 359–423.

[17] Ernest Bénévent, Le climat des Alpes françaises, pp. 93–94.

FIG. 11

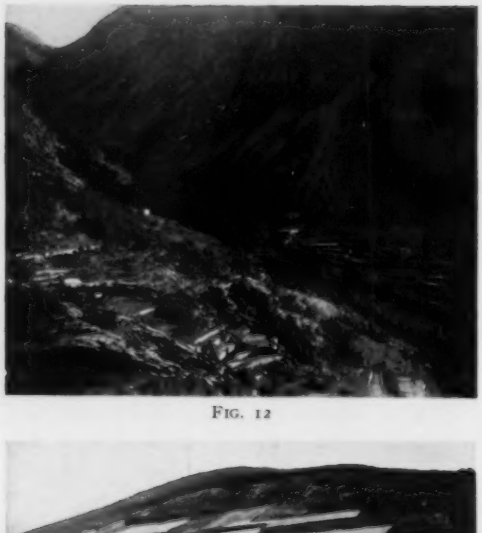

FIG. 12

FIG. 13

FIG. 11—Contrast in the utilization of the ubac (foreground) and adret (background), in the valley of the Isère.
FIG. 12—Adret and ubac (in shadow) in Andorra.
FIG. 13—A high side valley near Luchon, French Pyrenees. The limit of fields throughout the valley is about halfway up the slope regardless of height because of poor soil.

less important as altitude increases. There is no such definite zoning. In high mountains of varying detail of topography, the decrease of air temperatures is so irregular as to defy generalization. At the high levels where the intensity of insolation is greater, agriculture is more a slave to exposure than is the case at lower levels. The opposite may be true of grasslands. High insolation on a well exposed alp may cause evaporation excessive for pasture plants. Alp lands in the shade may have the more luxuriant grass. Relations between air temperatures and insolation values at high levels are suggested by the following measurements. These were made in a cirque (2250 meters) just north of the Porte de Vennasque, Pyrenees, at ten in the morning of a July day. Whereas the actinometer read 46.5° C., the air temperature in the shade was but 13°; in the sun it was 17° and close to a rock surface 19.5°.

Generally speaking the diurnal air-temperature range decreases with altitude, exposure and topography being equal. But on a sunny slope, other things being equal, the excess of soil temperature

over air temperature increases with altitude. This is most significant in extending height limits of agriculture beyond what otherwise would seem normal. But into the matter enter other factors beside those mentioned, such as nature of the soil, nature of the bed rock, and amounts of ground water. The less the mountain mass and the more isolated the peak, the greater the decrease of air-temperature ranges upon alp lands. The frequent noon cloud over alp lands in summer lowers the diurnal temperature range. Thalwegs are abnormally cold at night because of drainage of cold air down the slopes. As the precipitation and humidity of adjacent valleys are in direct contrast, likewise the diurnal air temperatures vary.

FIG. 14—The agricultural region of the valley of the Doron is too irregular to be called a zone.

EXPOSURE TO THE SUN

From the human point of view the most critical meteorological element in mountains is sunlight. The matter of sunlight is so dominant that each dialect of European mountain peoples has a set of terms for sunny side and shady side. Thus the German, *Sonnenseite, Schattenseite; Sonnenberg, Schattenberg;* French, *adret* (Latin, *ad directum*), *ubac* (Latin, *ad opacum*); *endroit, envers;* Italian, *indritto, inverso; adritto, opaco;* Catalan, *sola, baga; solana, ubach; soula, umbaga.* One may so name a village or a shady portion of a village, as Envers de Fontenille or Inverso Pinusca.

It is the field in the sunlight that brings the high price. It is the poor whose fields are in the shade. The angle of incidence of the sun's rays with the ground is a critical matter. Not only does the angle of slope of a sunny side give it an advantage over the level thalweg, but the shady side has less heat from the sun than the thalweg.

Instances showing the higher limits of culture, be it field, forest, alp, or village site, in the sun than in the shade, are as numerous as regional studies in mountain geography. The contrast of the two slopes is quickly observed by the traveler. But exposure to sun's rays as a factor is frequently reduced in importance or even devitalized by contributing factors. One must remember, moreover, that not even the simple relations of slope and sun's rays are constant for a

single slope. This is especially true in that alpine valleys commonly flare at the top of the valley cross section. The result is that there is normally a lesser difference between sunny and shady sides of alp lands than of the lower slopes.

Among the modifying agencies is the geological factor, which operates through soil, character of relief, mass of mountain, and ground water. Primitive crystallines commonly develop mountains with greater mass of mountain, gentler slopes, and better ground-water conditions than do limestones. All of these factors create in cases higher culture lines. Sieger gives an example showing a higher limit for alm huts on primitive crystalline rocks than on calcareous, even when the former represent the shade and the latter the sun exposure.[18] The matter of soil patently influences not only the height limit of agriculture but its character. A calcareous soil is warm and dry. Crystalline rocks may give rise to infertile siliceous soils or to fertile clays. In the Dolomites and Carnic Alps the beech finds highest limits in limestone and lowest limits in siliceous rocks regardless of exposure. The geologic factor influences slope. Great degree of slope, besides its more apparent influence on cultures, increases avalanches and landslips which locally have more effect in lowering cultural lines than might at first thought be realized.

Valley of the Doron

A personal study of a Tarentaise valley in the French Alps (Vallée de Doron) illustrates well the number and strength of factors other than insolation which determine height limits of fields.[19] The valley has an east-west trend and so a well defined *adret* (sunny side) and *ubac* (shady side). The *adret* has vines, grains, and hay. On the *ubac* hay predominates and there are some grains. Garden truck characterizes both. There are distinct agricultural regions which extend upward to the forest or, where the forest has been cleared, to the pastures. Above the predominately agricultural regions lie isolated fields on the *mayen*, or *voralp*, the lowest phases of alp land, the site of the so-called summer villages. On the *ubac mayen* grass predominates and fields are scarce. Sunlight is too slight for the best field culture, and yet grass flourishes well here. There are fields on both *mayens* above the true agricultural zone. The cattle rest on the *mayen* for a fortnight in spring and autumn each and also are found in the *mayen* stables for a period in mid-winter to eat the hay stored there. The amount of manure collected then is considerable. The greater the manuring of the fields the shorter the growing season necessary

[18] Robert Sieger: Beiträge zur Geographie der Almen in Österreich, Graz, 1925, pp. 1–14.

[19] Roderick Peattie: La question de l'adret et de l'ubac, *Rev. de Géogr. Alpine*, Vol. 18, 1930, pp. 175–187. See also the description of the region by Philippe Arbos: La vie pastorale en Tarantaise, *Ann. de Géogr.*, Vol. 21, 1912, pp. 323–345.

for an economic crop. But even though the *mayen* fields are in part due to fertilizing, I was not convinced that the height limit of crops was reached everywhere in the valley. The amount of land in a pastoral-agricultural valley to be devoted to crops is an economic matter. A commune attempts to balance properly the amount of land given over to crops, to meadows, to pasture, and to forest.

The matter of topography is intimately connected in the valley of the Doron with vine culture. The vines are confined to the *adret* of the postglacial gorge. It is a slope too steep for other cultures. On the *ubac* the gorge is devoted largely to forest. The vines are then a result of high insolation on land economically of no other use. But the vines give out as soon as one ascends from the gorge to the gentler slopes of the valley. This is not because the climatic height limit of vines has been reached but because the land is needed there for more important crops. Whereas it has been stated as an axiom that villages are by the rule in the sun,[20] the exception being rare, in our valley twelve villages lay on the *ubac* and seven on the *adret*. This valley is a decided exception because the *ubac* has better facilities for a low-level road. The villages are along the road.

Soil and Slope

Oversteep slopes have no soil. Such slopes commonly have alluvial fans or cones at the base. These deposits, though in places subject to torrential floods, may be loosely compacted and consequently well drained. If the gradient of the erosive portion of the stream's course is not too steep, the deposit may be fine enough for agriculture. Much depends also on the character of the rock suffering erosion. These cones of dejection are favorite sites for fields and villages. When on the *adret* they are better insolated than the thalweg. They are less exposed to cold air drainage than the valley. They are less subject to floods. Bénévent has made a physical-economic study of a cone dejection in the valley of the Isère.[21]

There is perfect gradation from the alluvial fan to a sheet of soil lying on a slope. On a moderately steep slope soil formation may not be sufficiently rapid to cover the entire slope in view of soil slip and soil erosion. In such case perhaps only the lower half of the slope will have soil suitable for agriculture. As one passes up the valley both stream profile and crest of the flanking mountains increase in altitude. Likewise the limit of the fields rises. One immediately suspects that the field limit is higher because of greater mass in the interior of the range, but quite commonly the increasing field limit

[20] For example see Roland Bonaparte: L'influence de l'exposition sur le site des villages dans le Valais, *La Géographie*, Vol. 11, 1905, pp. 212–216.

[21] Ernest Bénévent: Le Manival: Étude de cône de déjection, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 3, 1915, pp. 69–100.

is a question of soil. The soil maintains its proportional cover of the slope regardless of the increasing elevation of the slope. Perhaps the most common error in studying height limits is to ascribe to climate a cessation of culture due to thinning of soils.

Winds

Exposure to prevailing winds means greater precipitation or greater evaporation or greater warmth or greater cold, as the case may be. These matters need no explanation, but we may cite a few instances of their potency. Even low mountain peaks suffer excessive evaporation, more so apparently than at the equal altitude on a flank of a large mountain. Other things being equal, in so far as this factor is concerned the highest mountains ought to have the highest forest limits.[22]

Mountains	Heights	Forest Limits
Carpathians	4000 meters	2000–2100 meters
Massif Central of France	1800 "	1400 "
Vosges	1300 "	1000 "

The absence of forests on such modest elevations of the Plateau de Vercors (French Alps) as rise to 1585 and 1710 meters is ascribed definitely to the western exposure to winds.[23] The violence of winds increases with exposure and with altitude. Relief will, of course, give protection from the wind, but also broken relief generally decreases velocities and causes a variety of counterwinds and indrafts. A prevailing wind for a region is not necessarily the prevailing wind for a valley. An example of increase in velocity with altitude is given by de Martonne in the following table for stations in the Alps:[24]

Mountain	Altitude	Velocity (*minutes and seconds*)
Kremsmunster	390 meters	3.5
Säntis	2500 "	7.5
Sonnblick	3100 "	9.3

The effect of mountain and valley winds in somewhat equalizing the contrasts of the sunny slope and shady side has been discussed by Bénévent.[25] The mountain wind of evening is merely the expression

[22] Emmanuel de Martonne, La Valachie, p. 96.

[23] Paul Mougin: La question du déboisement des Alpes, *Rev. de Géogr. Alpine*, Vol. 12, 1924, pp. 497–545; reference on p. 527.

[24] Emmanuel de Martonne: Les Alpes, Paris, 1926, p. 91.

[25] Ernest Bénévent, Le climat des Alpes françaises, pp. 104–106.

of the downslope drainage of cold air. The most studied and perhaps the most interesting wind of mountains is the föhn. Whereas in literature a great deal is made of its destructive force, its first importance is an aid to agriculture, particularly vine culture. There is a proverb that says two days of föhn are worth fifteen days of sunshine.

Economic Factors

Only brief reference can be made here to economic factors governing the height limits of cultivation. A wealth of data is available in the literature of European mountain studies. Mountain regions of the temperate zone are difficult to farm. They are the last places which economically are chosen. Cholley points out that effective colonization and peopling of the mountains of Savoy did not take place until the eleventh and twelfth centuries.[26]

Particularly has transportation changed mountain economies. Railways have broken down the economic independence of the Swiss valleys with an attendant change from an emphasis on breadstuffs to concentration upon dairying. As the Swiss mountaineer today largely buys his flour, cereals are found on the lower, more favored fields. The cereal limits have been descending.[27] The vine limit has been lowered in the French Pyrenees because the cost of labor since the war increased, whereas the price of wine did not increase at so rapid a rate. The vine limits were lowered, and in places vine culture was discarded. Now, with the gradual increase in the price of wine, vines are again creeping up the mountain sides. An example of the local change of agricultural economy in the French Alps is noted by Monnet,[28] of change in pastoral economy by Arbos.[29]

Because of the economic conditions of the time, and of the topographic and climatic peculiarities of the region, there is a momentary proper balance of the use of land in a given region—how much is best left in field, in forest, and in pasture. The high communes often have an excess of high sheep pastures; and, though the economy of sheep raising may not be favorable during a given period, the land can be devoted to nothing else. Mountain men have become more and more aware of the fact that the economy of a valley is best served by the preservation of a considerable extent of forests. Forests, besides their direct monetary value, are of importance in that they store water, prevent soil erosion, keep streams free from sediment, retard avalanches and landslides, in cases provide some pasturage, and, of

[26] André Cholley: Les Préalpes de Savoie et leur avant-pays, Paris, 1925.

[27] A careful study of changing economy has been made by Niklaus Forrer: Zur Anthropogeographie des alpinen Thurtales, Inaug. Diss., Bülach, 1925.

[28] Paul Monnet: Le pays d'Allevard, *Rev. de Géogr. Alpine*, Vol. 15, 1927, pp. 71–132; reference on pp. 96 *et seq.*

[29] Philippe Arbos: L'Économie pastorale dans quelques vallées savoyardes, *Recueil des Trav. de l'Inst. de Géogr. Alpine*, Vol. 1, 1913, pp. 45–83.

course, provide fuel. Indeed in western Europe the forest limit is almost always an economic limit when not controlled by topography. It is much less often climatic than one might suppose. One must make distinction between the forest limit and the tree limit. The tree limit *is* climatic. To understand what are the causes controlling height limits of forests in any one region, one should study the amount of upland pastures, the amount of land devoted to crops, and the amount devoted to hay. On a farm on a plain without the mountains, the amount of land left in wood lot is an economic, not a climatic, matter. Though the case is not so simple in a mountain valley, nevertheless economic factors must here also be taken into consideration. Because of the commonly prevailing communal ownership in valleys, an entire basin may be thought of as an economic unit.

These notes, prepared in the course of study directed towards the formulation of principles of mountain geography, make no pretense of completeness. No factor regulating height limits of culture has been fully considered in all its intricacies. Whole groups of factors, such as the social, have been left unnamed. The huge bibliography on mountain geography is but hinted at. My purpose is to suggest the opportunities for study in this most interesting field.

NAVAJO NOMADISM

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THE Navajos are by far the most numerous full-blooded tribe of the Indian population of the United States and they occupy the largest continuous area of land reserved in it for Indians. An area of 22,400 square miles is included in the combined reservations for the Navajo and Hopi Indians, a territory larger than that of Holland and Belgium combined. This great block of country, particularly the part in Arizona, is difficult of access, and, in spite of a wealth of scenic marvels, most of it is scarcely touched by tourist travel which surges around it. Considerable areas are still reached only by trail. Within the area is the post office most remote from railway communication in the United States—Kayenta, 160 miles from Flagstaff, Ariz., which receives mail twice a week. The reservations are untouched by railway; roads are few and almost entirely self-made. Only one road worthy of the name traverses the country north and south; that from Gallup to Ship Rock on the San Juan River, a distance of 90 miles—the only gravel surfaced road in the Navajo country. From Ship Rock, fairly good roads extend northward and eastward up the San Juan into Colorado. Other roads lead to the agency centers at Crown Point, N. Mex., Fort Defiance, Keams Canyon, and Tuba, Ariz. These are worked on and are usually passable or even good. The Navajos, women and children as well as men, are much in the saddle, and travel is largely on horseback. The Navajos have few wagons as compared with other Indian tribes; but a few of the wealthiest have cars, especially around Ship Rock, where road connections offer the inducement and a few oil wells afford the means.

The Navajo Country

The Navajo country is a land striking in color, with grandeur of scale and form; but, for all its scenic interest, it is a poor country, and its chief resource is natural forage. Even that, judged by the standards of more humid lands, is poor enough. In spite of diversity in physical features, climate, and grazing conditions, all the reservation areas in a broad sense show common features resultant of an arid or semiarid climate controlling the denudation of an area of great relief, with also a dominance of resistant sedimentary strata,

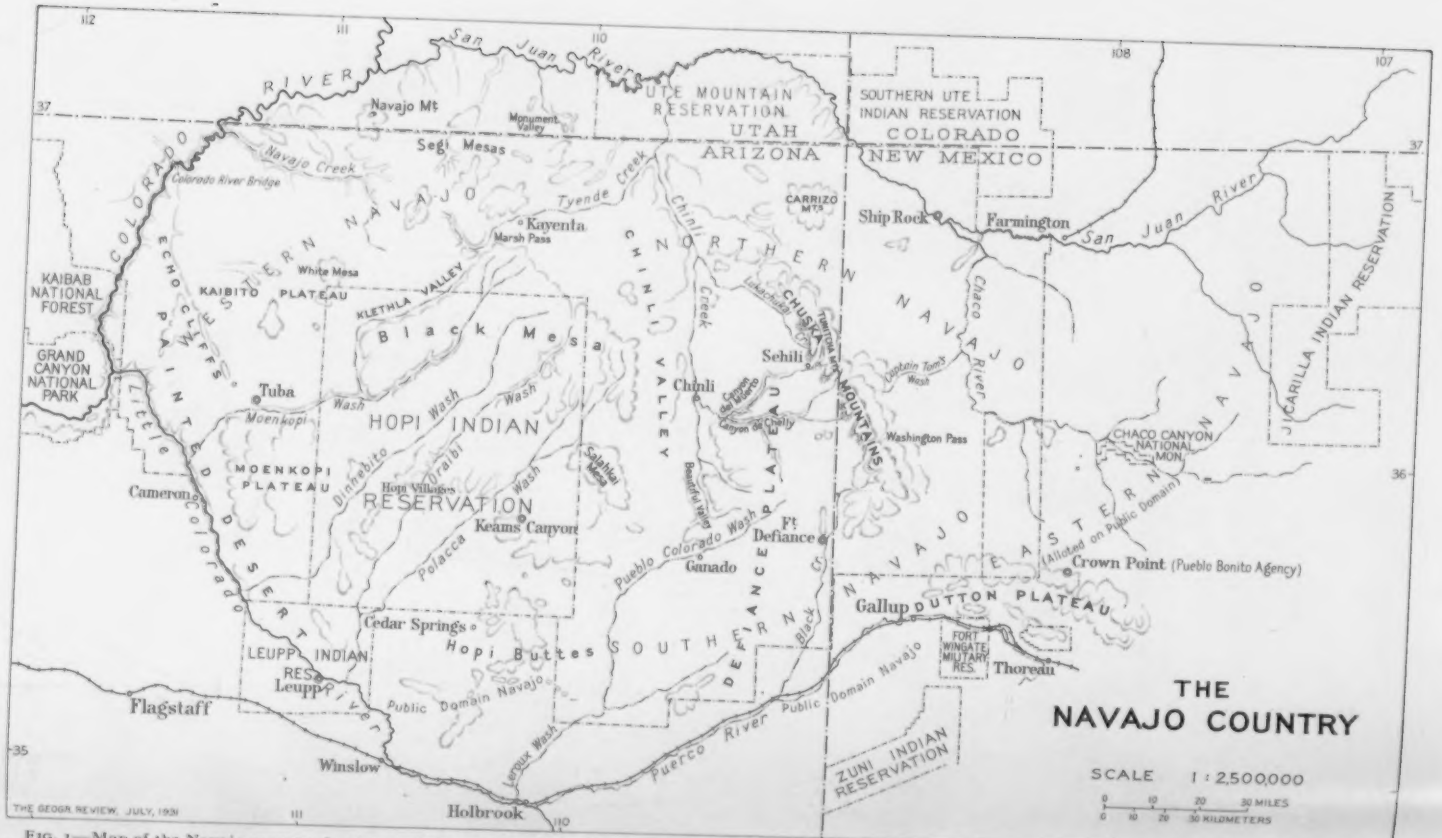

FIG. 1—Map of the Navajo country showing the Indian reservations. The Indian population of the reservations is estimated at some 40,000 Navajos (about five-eighths in Arizona, the remainder in New Mexico), 2800 Hopis, and 200 Piutes. The white population of the area comprises about 600 traders, missionaries, teachers, or other government employees.

essentially horizontal, but slightly disturbed diastrophically or vulcanically—plateaus of uplifted peneplains now mostly in a youthful stage of erosion.[1] The influence of aridity and spasmodic rainfall is manifest in the dry stream channels, the enormous accumulations of coarse alluvium, sand dunes, bed rock in places swept bare by wind or sheet wash, bare rock walls which in a humid land would be buried under talus, and harsh lines generally.

The area is for the most part more than a mile high with about a tenth of it more than 7000 feet high. The greatest elevation is reached in Navajo Mountain (10,419 feet). The mountains and higher plateaus have cool summers and cold winters with heavy snow fall, the rainfall being generally more than 12 inches and in some places more than 20 inches. The most populous part of the Navajo country is the higher and better-rained-on portions about the Chuska Mountains and Defiance and Dutton plateaus near the Arizona and New Mexico boundary. The area tributary to the Fort Defiance agency alone contains nearly half of the total Navajo population, while the larger Western Navajo Reservation contains hardly a fifth of it.

The lower areas are fairly hot in summer and mild in winter, with less than 10 inches of rain and as little as 5 inches or less along the lower courses of the Little Colorado and on the San Juan. The months of July, August, and September average a little more than a third of the rainfall for the year. The rainfall for July is particularly critical both for pasturage and for corn.

In the lowest areas one encounters a desert flora, a sparse vegetation with scattered cacti, yucca, and tuft grasses. Above 5000 feet the flat or gently sloping areas are characterized by sagebrush (*Artemisia*) or tarweed (*Isocoma*), and rabbit brush (*Chrysothamnus*) with greasewood (*Sarcobatus*) on the salt and alkaline flats or along the drainage channels. Scattered juniper makes its appearance at about 6000 feet; and, as the elevation increases, piñon (*Pinus edulis*) also appears and finally dominates. Above 7000 feet is the yellow pine belt. The largest stands are on Defiance Plateau and the western side of the Tunitcha Mountains, with scattered stands on the higher parts of the other highlands.[2]

Vegetation associations of cacti, sagebrush, or timber do not suggest good forage; but in the sage and juniper belts are many spaces in which the nutritious grama grass naturally flourishes, while in the high areas the trees stand well apart with grassy forest floor.

FIG. 1—Map of the Navajo country showing the Indian reservations. The Indian population of the reservations is estimated at some 40,000 Navajos (about five-eighths in Arizona, the remainder in New Mexico), 2800 Hopis, and 200 Pimas. The white population of the area comprises about 600 traders, missionaries, teachers, or other government employees.

[1] H. E. Gregory: The Navajo Country, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 561–577 and 652–672; *idem:* The Navajo Country, A Geographic and Hydrographic Reconnaissance, *U. S. Geol. Survey Water-Supply Paper 380*, 1916; *idem:* Geology of the Navajo Country, *U. S. Geol. Survey Professional Paper 93*, 1917.

[2] For a description of these associations see the article "Forests," by Raphael Zon, in O. E. Baker: Atlas of American Agriculture, Part I, sect. E, Vegetation, U. S. Dept. of Agric., 1924.

Even in the most arid parts, after summer showers grasses spring up and quickly reach maturity before the soil completely dries out.

Nomadic Movements

The character of the country with the economic basis adapted thereto necessitates considerable movement, but such movement is no longer pure nomadism. For the Navajo, no matter how far he may wander, returns again and again to the same spot or general vicinity. Steadily increasing population, with fuller utilization of their lands and encroachments on one another's prerogatives, has compelled the Navajos to confine themselves to particular grazing lands and to follow a more or less regular beat. Their movements have thus come to resemble to some extent those of the Papagos between localities.[3] Many of the Navajos do not move very far from their base.

While most of the movements of the Navajos are in the nature of transhumance, there is no one rule that governs such movements. Seasonal they are in the main; but, as conditions vary with localities, the movements also vary; so that for the same reason the Indians may regularly move up in some localities and to lower land in others. The migrations of the Navajos and their pastoral pursuits are withal of paramount importance in controlling their *mores*, their housing and diet, and the outward indications of progress.

The movements of the Navajos may be classified thus:

1. Moves between summer and winter pastures
2. Seasonal moves controlled by temperature conditions
3. Temporary moves for summer farming
4. Winter moves to convenient fuel
5. Moves after showers for pasture in the drier parts
6. Moves in search of water for domestic purposes and for animals
7. Autumn moves for piñon nuts and for peaches
8. Moves for social reasons

In reality the movements of the people in any locality are quite complex and involve various combinations of the above categories. Most of the Navajos have definite summer and winter localities, between which they move, and summer and winter hogans to which they return with the changes of season. The distances thus traveled vary from a few to sixty miles. The mountains and highest plateaus afford well watered summer pastures. This permits the open pastures of the surrounding lowlands to grow undisturbed under the stimulus of the summer rain. Then, as the winter comes on with

[3] J. W. Hoover: The Indian Country of Southern Arizona, *Geogr. Rev.*, Vol. 19, 1929, pp. 38-60, especially pp. 49-55.

FIG. 2

FIG. 3

FIG. 4

FIG. 2—Great gully south of Ship Rock resulting from recently rejuvenated erosion and illustrating the difficulties of road building in the region. Remnant of ancient volcano at the left.

FIG. 3—Cultivated fields along the San Juan River looking east from the terrace, above Ship Rock, N. Mex.

FIG. 4—Ship Rock Indian Agency, with Ship Rock, a volcanic neck, in the distance.

its snow cover on the highlands, the flocks are driven down to the lowlands. Physical comfort also plays its part. The highlands are cold and snowy in winter but cool and pleasant in summer. The lower lands are fairly hot in summer and comparatively pleasant and free from snow in winter.

Around the Eastern Highlands

Illustrations of the above types of movements are best found in the eastern part of the reservation area; as for instance between Dutton Plateau and the lower lands to the north, Lukachukai Valley and the Chuska Mountains, the Carrizo Mountain and the valleys that radiate from it, Black Creek Valley with the surrounding highlands and the lower lands to the west. In the vicinity of Crown Point, situated at the base of Dutton Plateau, the Indians move only about twenty miles between summer and winter camps. Some settle around the base of the plateau for the summer, and others go on the top. They move up some time in June and back to the lower lands between the middle of September and the first of November. The Indians of the lower Lukachukai Valley move up the valley and drive their flocks up into the mountains via the Lukachukai Pass in June. Some of the Indians who winter in the Lukachukai Valley go some twelve to twenty-five miles farther south for the summer to the headwaters of the De Chelly and Del Muerto at Sehili and Wheatfields.

Farther south, in the area tributary to Fort Defiance in and around Black Creek Valley, there are no near lands low enough to be free from winter snow; and, though the area is comparatively populous in summer, few Indians remain through the winter. Most of the sheep are moved into the Chinle country to the west for that season. They move to the higher lands again in the spring, especially when it is dry, and on to the mountains when the snow melts and the feed starts. All have their ranges, and some sheep move as much as forty or fifty miles between summer and winter ranges.

Navajo Agriculture

Most of the Indians who migrate as thus described practice very little agriculture. But in other parts the summer location is determined primarily with reference to agriculture. A number of small favorable areas are thus nuclei for summer settlements, and an increasing number are remaining more or less permanently in these places and devoting themselves primarily to agriculture. Thus we find Sehili to be a summer agricultural community at the base of the Tunitcha Mountains, on the western side, irrigated from the permanent mountain stream, Del Muerto, that flows through the valley.

FIG. 5

FIG. 6

FIG. 7

FIG. 5—Open grassy yellow pine forest, typical of the highest parts of the Navajo country. Tubby Butte, remnant of a thick ancient lava sheet, in the background. Tunitcha Mountains, Arizona.

FIG. 6—Brilliantly colored and virtually useless badlands, "Painted Desert," in Chinle formation, north of Adamana, Ariz.

FIG. 7—Road to Crown Point through Satan's Pass, Dutton Plateau. Piñon zone.

Likewise Lukachukai Creek supplies water for several hundred acres of fertile alluvial land on the fan at the mouth of its mountain gorge. The soil here is deep and fertile and becomes increasingly fertile toward the canyon. The district is irrigated by the permanent mountain stream and supports several hundred Indians. They farm mostly alfalfa, which is worth about $28 a ton at Fort Defiance after a haul of sixty miles; and their greater prosperity is reflected in their homes. Somewhat similar communities are found elsewhere around the Chuska Mountains. On their eastern flank a rough-floored terrace, a mile or two in width, extends over outcropping beds of shale at the base of the yellow-gray cliffs of the sandstone formation that caps the mountain.[4] About thirty springs emerge from the base of the sandstone between Tohatchi and Washington Pass, and more than a third of them are utilized to water the fields of prosperous Navajo farmers. They have both summer and winter quarters and produce grass, corn, and potatoes. The largest of the springs yields water enough for the fields of about fourteen Navajo families. A considerable area is also irrigated along the San Juan River under the wing of the Ship Rock agency. Some of this is farmed by the Indian employees of the agency, who have ten or fifteen acres each. About 2000 acres tributary to Captain Tom's Wash, a branch of the Chaco, are under ditch; but only 500 acres were under cultivation in 1928. Otherwise there is practically no cultivation east of the Chuska Mountains.

In the San Juan and Chaco Country

Along the San Juan, especially in the neighborhood of Ship Rock, the Indians move to the river for the summer months. They come here partly to utilize the farm lands along the river, partly for the water supply the river affords, and partly to save their winter pasturage. Mostly their hogans are found scattered on the terrace which rises abruptly a half mile to a mile away from the river. These summer sites are bare and desolate-looking, without shade or water near. They are located with reference to pasture convenience, the flocks being grazed on the lands above extending back from the river. Their fields are below the terrace on the river flat.

In the winter these people move back from the river to the mesas, usually not more than fifteen or twenty miles. The pasturage is thin in the river zone. Furthermore, it is cold as the country is open and the winds sweep along the river. The winter hogans are built, not on top of the mesas, but under their sheltering cliffs. Here the animals as well as the people can find shelter from the winds. Air drainage tempers the cold of the night, and the rocks absorb the heat of the

[4] Gregory, *Water Supply Paper 380*, pp. 140–141.

sun during the day and radiate it during the night. Springs and seeps emerging from the bases of the cliffs, or in the washes, supply water. The mesas are also in the juniper zone, and wood is available for fuel. Coal is used when available, and in the San Juan section some of the Indians have their own little mines.

Essentially similar are the movements of the Indians in the Chaco country, south of the San Juan. There are no permanent streams there, but the Indians always know where water can be found; there are many springs or seeps unknown to whites passing through. The Chaco Canyon has an underground flow, as do some of its more important tributary washes. In these the Indians dig for water for both man and sheep. In fact the stream takes its name from the *charcos* found in it where tributaries enter. In the winter the Indians go back to the mesas, where they obtain water by digging in the washes coming out from them. Here, too, they find fuel and the protection of the sheltering cliffs.

Chinle Valley and West

From the Chinle Valley westward, as in the San Juan and Chaco valleys, the seasonal migrations are quite the reverse of those noted around the major highlands. Here the treeless valleys are wide and fuel is more distant. The Indians show a marked disinclination to haul fuel, it being to their notion easier to move themselves and their belongings. In the middle belt of the reservation, as represented especially by the Chinle and Pueblo Colorado valleys, they do some farming in the summer, depending for water upon the normal drainage of these washes, largely underground. East of this belt, as we have noted, the small areas suitable for farming are at high levels, where streams emerging from the mountains afford irrigation in small fertile alluvial valleys. Farther west, water and fertility are to be had only locally in the lower lands along or near the washes especially at the mouths of arroyos where the waters may be spread out over the land after rains. The Navajo agricultural practice is here very similar to that of their Hopi neighbors. And so, in order to farm, it is necessary to move to the valley bottoms in summer. In the winter the movement is from the valleys to the nearest mesas, where juniper or piñon can be found for fuel and water can be obtained from melting snow.

The juniper zone is also highly desirable for winter pasturage. The snowfall is not so heavy as to preclude grazing, as it is in the higher pine belt. Instead, the low-spreading branches of juniper and the sagebrush in the open spaces hold the snow which forms a shelter for the forage and the sheep grazing underneath. Such winter grazing is found at its best over the central and southern parts of the

Black Mesa. The Navajos who live there do not move off the mesa but make a circuit in summer, returning always to their winter hogan. Each clan has its definite grazing grounds and water holes which are respected by the others. The high, steep escarpment that borders the northern sides of the mesa prevents free movement from it in that direction.

The Indians of the Chinle Valley remain there until the corn harvest in October, then they move off to the margins of Defiance Plateau or of the Black Mesa. Some seventy-five or eighty Indians go for the summer into the Canyon De Chelly, which opens into the valley at Chinle. The canyon is famed for its towering walls of red sandstone. Its bottom is flat, of deep sand, and, except after heavy rains, dry; but water may invariably be found a short distance below the surface. In places the bottom is high and stable enough to support corn patches upon which the Indians depend.

Little patches of peach trees are also found in Canyon De Chelly, about the only place where they are cared for by the Navajos. The seedlings were originally brought in by the Spanish padres. The fruit is fine and of unique flavor; it does not ripen until late in September or early in October, when the Navajos go to the canyon in numbers.

During the peach season at the Hopi Mesas the Navajos come from twenty-five or thirty miles around to trade mutton or goat's meat for peaches. The Hopi women watch for their coming from the mesa heights, as eager to secure the meat as the Navajos are to secure the peaches. The Navajos stay around the mesas for some time eating as many peaches as they can. They also trade for the dried fruit, and the medicine men take a large quantity away to use for purgatives.

In the country of the washes, between the Black Mesa and the Little Colorado River, fuel is distant; and many of the Indians who farm along the Polacco Wash remain through the winter. Hopi Indians will spend three days in getting a load of fuel, but the Navajos have less patience. They are therefore dependent upon the light greasewood brush as the only available fuel, and in the severe weather their suffering is sometimes acute. At such times the children can be seen dragging in greasewood all day long. It is burned outside the hogans to get rid of the smoke, and the hot coals are taken indoors. In the distressing winter of 1918 these people died like flies, victims of influenza and the severe cold.

Some of the people of the washes go east to the Hopi Butte country in the winter. Although the grazing here is not so good as along the lower washes, some juniper grows on top of the buttes and mesas, and springs emerge from underneath the basalt that caps them. Most of the Indians living here move about within the area.

FIG. 8

FIG. 9

FIG. 10

FIG. 8—Greasewood Springs, a remote trading post near Lukachukai Valley, in the juniper zone. The greasewood, formerly abundant around the springs, has been tramped out.

FIG. 9—Navajo flocks brought in to water, near Crown Point, N. Mex.

FIG. 10—Navajo hogans, or log huts, the acme of Navajo house building, near Red Lake, north of Fort Defiance, Ariz.

The Water Supply Factor

In the region west, toward the Colorado River, water is a more important factor in controlling migration than farther east. As in the middle belt the shift is toward the timber in the winter months and toward the non-timbered sections in the summer, to seek land where small crops may be produced. A number of Navajos farm on the Tuba Oasis in summer, but for the winter they go back to the rivers in the canyons to the north where juniper is available. In the dry seasons of spring and fall no water can be had on the higher, timbered sections represented by the White Mesa, the western border of the Black Mesa, and the canyon country to the north; it must be sought at lower levels. As the rains come the Indians move farther back to the higher and better pastures, whether it be summer or winter. As necessity demands they move to the places with permanent water.

In the Klethla Valley, northwest of the Black Mesa, the water pockets are dry except in July and August; and so for most of the year the people either go to Red Lake to the southwest or seek the springs around the mesas. In the canyons of the Segi Mesas there are plenty of springs and even running water. Here one may see a number of cattle but very few Indians, as they prefer to be out in the open country at Marsh Pass, Kayenta, and Monument Valley. One reason for this may be the presence of many cliff dwellings, which they call "cities of the dead."

Much of the western end of the reservation is quite desert and for the most part uninhabited; but in the summer time local showers cause the grass to spring up, and, as is characteristic of desert borders, the Navajos follow the showers seeking pasture for their flocks. Hollows in the rocks called "pot rocks," or "tanks," catch and hold enough water temporarily for the flocks and their herders.

The government has considerably improved the water supply on the reservations by the development of seeps and springs and by the digging of wells. About twenty wells are now scattered along the Chinle and Beautiful valleys, and about twenty-five have been dug on the Hopi Reservation. Fifteen of these, in the southeast of the Black Mesa area, are for the Navajos. There are also about seven pumping wells along the Pueblo Wash and about nine in the Lukachikai Valley. On other parts of the reservations the wells are widely scattered. In the Chinle district the stock doubled after the wells had been dug. The Navajos show no disposition to cluster closely around the wells or springs. They may build their hogans some miles away from any water supply, for the sake of privacy. If they live at a distance from a well or spring they drive their flocks to it every other day in summer or only once a week in winter. They also bring

barrels by wagon and carry back a domestic supply. Man and beast get along with a remarkably small amount of water.

Administrative Difficulties

Considerable difficulty has been experienced in the eastern Navajo jurisdiction of New Mexico.[5] For centuries Navajos have occupied and roamed over this area, which unlike the other reservations is public domain open to settlement. In 1887 the General Allotment Act was passed providing for Indian allotments on the public domain. The semiarid character of the country and the Navajo's pastoral economic basis do not lend themselves to successful allotment. But allotment is proceeding nevertheless. Increasing pressure is being brought by whites to drive the Indian nomads back onto the other reservations where allotment is unnecessary; but these lands are already overpopulated and overgrazed. Considerable difficulty is experienced in getting the Indians to stay on the allotments, and many of them are incapable of supporting even a Navajo family.

Two other difficulties present themselves in this area. First there are a number of homesteaders, mostly Mexican sheep herders, that are a constant source of friction with the Indians. Second, in order to encourage the building of the Atlantic and Pacific Railway, now the Santa Fe, alternate sections of land extending back fifty miles from the railway were granted. The Indians have wandered over these lands without recognizing boundaries. Others have established homes and water storage for which they cannot get title. The railways are also reluctant to make exchanges, as they could not get title to minerals on lands taken in exchange.

On all the reservations the problems due to overgrazing are receiving attention. Large numbers of Indian ponies, almost worthless, have ranged the country, helping to reduce its forage. A few families have owned as many as 300 to 400 ponies each, which are useless because never broken. One of these horses eats as much as eight sheep and drinks about nine gallons of water to a quart drunk by a sheep. An effort is being made to reduce the ponies to the small number needed for hauling, and, wherever the Indians can be induced to part with them, they are taken and sold for from $2.00 to $2.50 in Gallup, N. Mex., where a plant has been established that grinds them up into chicken feed. The use of horse meat is also increasing as a more profitable disposition of the ponies.

The Navajo House

The Navajos cling tenaciously to their primitive hogans, or "quagans," as they were originally called. In terms of sheep some

[5] Included within this jurisdiction are three outlying groups of Navajos, numbering about 750, at Puertecito, Canoncito, and immediately east of the Zuñi Indian Reservation.

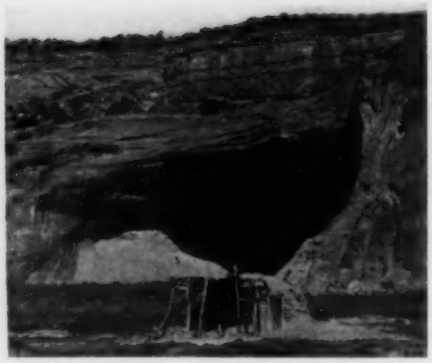

FIG. 11

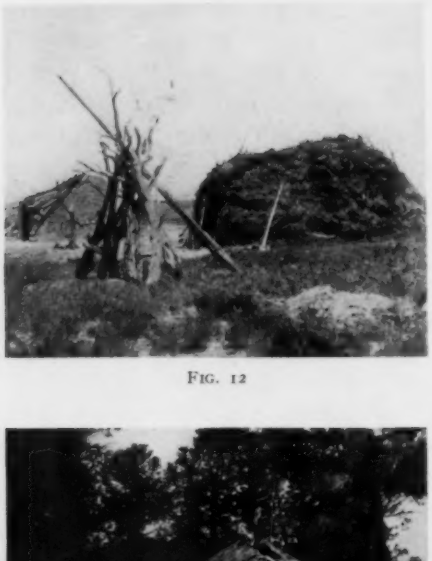

FIG. 12

FIG. 13

FIG. 11—Navajo hogan and great recess, or cave shelter, in Wingate sandstone, used as a sheep corral. In New Mexico, near Leupp, Ariz.

FIG. 12—Navajo hogans, Western Navajo Indian Reservation.

FIG. 13—Typical primitive winter hogan in piñon belt, with scattered yellow pine, just above Sehili Valley.

of the Navajos are now quite wealthy, having as many as 1500; but they do not save money, and a larger income may mean little or no improvement in living conditions. As with nomadic peoples generally, the shelter must be of simple construction, easy to build, and of little loss if abandoned. Moveable property must be reduced to a minimum; hence Navajo homes often belie the actual condition of their occupants. The hogans are always at some distance apart, never in villages but grouped into communities where conditions are favorable for pasturage, water supply, and possibly some farming. The hogan is suggestive of the Indians of the plains, whence the Navajos are believed to have come. There is considerable variety in the structures according to the kind of timber available, the season, the length of time the site is to be occupied, and the culture or wealth of the owners.

The summer hogans may be almost anything that can be called a shelter, as a frame covered with brush or a stone wall to protect from wind. The original and simplest type of winter hogan is somewhat conical. The structure is supported by five poles with forked ends, coming together at the top, with smaller poles laid closely together between and interwoven with boughs

of juniper or an available substitute, the whole overlain with bark or brush, which is in turn covered with earth. Another type, which lends itself to larger structure, is made by laying six or more logs or limbs in the form of a circle and building a dome, which is plastered with mud or covered with earth.

In the neighborhood of Fort Defiance and the valleys to the north we find the best-appearing Navajo homesteads—log huts or houses of the common square form with low gable roof. In a few cases stones are used for the walls. Other forms suggest an evolution from the primitive hogan described above and the square log house. In the same community with the log hut may also be found the simplest of hogans and all intermediate stages. While the log or stone hut containing a stove and chimney may appear more progressive, it is a doubtful advance. Tight and stuffy, it is inferior to the hogan from the sanitary point of view.

Superstitions also discourage house building. If anyone dies in a hogan, the devil is believed to be in possession. Such devil or *chindi* hogans are abandoned and carefully avoided henceforth. Pools and even canyons may likewise become *chindi*. Thus, while Canyon De Chelly is seasonally inhabited, Canyon Del

FIG. 14

FIG. 15

FIG. 16

FIG. 14—Navajo hogan near Sehili, Ariz. An intermediate stage in the evolution from primitive hogan to log hut.

FIG. 15—Stone construction in Navajo hogan, near Crown Point, N. Mex.

FIG. 16—Hogan of Piute Indians, Southern Ute Reservation, Colorado. The Piute hogans are built like the larger, or medicine, hogans of the Navajos.

Muerto (Canyon of the Dead), a branch taking its name from a massacre of many of its inhabitants by the Spaniards, has been abandoned by them ever since. In order that they may greet the daily appearance of their chief god, the sun, all hogans have their doors to the east and are thus an unfailing compass in the Navajo country

Navajo Arts

This life, so closely adjusted to natural circumstances, is of comparatively recent date. Before the introduction of domestic animals the pastures of their country were of no direct use to the Navajos. They were then primitive nomads, an extremely poor people, subsisting largely upon roots and seeds and clothing themselves with the skins of such animals as they killed. The Navajos took no part in the insurrection of the Pueblo Indians of New Mexico against the Spaniards from 1675 to 1680 but took advantage of the struggle to rob and plunder and in this way secured many sheep and goats and captured some of the Pueblo women. Upon the return of the Spaniards many Pueblo Indians joined the Navajos rather than live again under Spanish rule. From the Pueblo Indians living among them the Navajos learned the art of weaving and improved upon the art until today they are noted chiefly for their blankets. According to their own traditions they had learned to weave cotton from the cliff dwellers before they had sheep. As the art is recent with them, the designs are in the main comparatively modern; many of them have been suggested by artists and traders as improvements or elaborations of their cruder primitive designs. Hence the Navajo woman does not, as is commonly supposed, know the meaning of her designs, if they have any, unless sand paintings furnish the motive; and some of the sand paintings are not allowed to be copied.[6]

A few black and brown sheep are found in every flock to supply black and brown wool for the blankets. Thus four natural colors of wool are woven into their blankets; gray being obtained by mixing black and white. The bright red that predominated in the old, now rare, *bayeta* blankets was obtained by unraveling imported *bayeta* bought from the Spaniards. The material was also used in old squaw dresses, which are now rare and almost priceless. All of the primitive Navajo dyes are the products of the prairie and mountain flowers or of bark and roots. The homestead scene is hardly complete without the characteristic Navajo loom suspended from a pole lashed between two trees if near, or if not, between two upright posts set firmly in the ground. The total annual production of Navajo blankets

[6] From the standpoint of art the sand paintings of the medicine men rival the blankets, but they are seldom seen by white people as they are purely ceremonial and must be destroyed at sundown. At the State Museum, University of Arizona, Tucson, under the direction of Dr. Byron Cummings, may be seen the only genuine Navajo sand paintings allowed to be preserved.

perhaps averages over $800,000 in value. Many blankets are sold off the reservation, and of these neither traders nor agencies have any record. In 1923 the receipts from the sheep and the related blanket industry were estimated at $350 for each Navajo family.[7] In 1929 the same authority estimated the average family income from livestock at $300, while as many as 2000 families engaged in weaving blankets had incomes averaging $400 each. In spite of some reduction due to protracted drought, the Navajos are today estimated to possess 650,000 sheep valued at $3,900,000; 200,000 goats valued at $400,000; 30,000 cattle valued at $750,000; 10,000 horses valued at $150,000. Receipts from sales of wool, lambs, cattle, hides, pelts, etc., totaled a little over $2,500,000 in 1928. This did not include livestock slaughtered for consumption.[8]

With the continued steady increase of Navajo population, some must necessarily leave the reservation. These people are certainly not yet to be numbered among the "vanishing Americans." And they and their country bid fair to hold out as an outpost of Indian culture and pure Indian population after all others have lost their identity.

[7] C. E. Faris: The Navajo Shepherd and His Problems, *The Native American*, Vol. 25, 1925, Phoenix, p. 13.

[8] Data supplied by C. E. Faris, District Superintendent of the Southwest, U. S. Indian Service, Albuquerque, N. Mex. From official correspondence, 1929.

DISTRIBUTION OF THE WORLD'S CITY FOLKS

A STUDY IN COMPARATIVE CIVILIZATION

Mark Jefferson

ESSENTIAL to a distinction of urban from rural is our conception of population. Let us think of population as more or less nucleated into villages, towns, and cities. Urban and rural, city and country are one thing, not two things. Rural folk are only distinct from city folk in their sleep, as is pointed out below. Awake and at work they are tied up to the city in every act of life. They raise crops for city people and get their clothes from the city. They are employed by the city on works in the country, and they bank and invest their money in the cities. They go to the cities for material things and such spiritual things as books, music, and education. Any individual you please, if you pry into his affairs, is found to pass his life in touch with the city, to act with reference to the whims and wishes of city people. A lonely man in the woods, trapper, hunter, and fisher, buys his supplies in a village, sells his pelts to the city, and makes his best income by guiding city folks hunting and fishing. Out of the season he corresponds with them. He has them more or less in mind all the time.

What is rather carelessly called rural population is only the least nucleated part of a highly nucleated whole. In the United States, for instance, up to 1900 the parts of the population "outside of cities of 8000 people" were called rural. There were thousands of villages and towns in that "rural population." The census admitted as much in 1900 when it lowered its quantitative definition of city to 2500. Even outside the "cities" of 2500 there is much nucleation, many smaller towns and more villages.

What Is a City?

It appears to be accepted among writers that urbanization means taking to the city life, but as to what constitutes city life there is wide disagreement. We often see comparisons of the percentages of urban or rural inhabitants in different countries. It is the writer's impression that these percentages are not comparable, being based on a great variety of definitions of a city. Yet the comparisons are made, and much that has been written about urbanization is insecure in its foundations because of the various definitions of city. Dr. W. M. Steuart, Director of the United States Census, has gathered many of

these definitions and the data derived from their use in an admirable table.[1] A dozen or fifteen countries define the city as a very small group of people, 500, 1000, 2000, or 5000, living in a close agglomeration. This clause, "in a close agglomeration," indicates a wish to rule out *communes* of scattered country population which have no

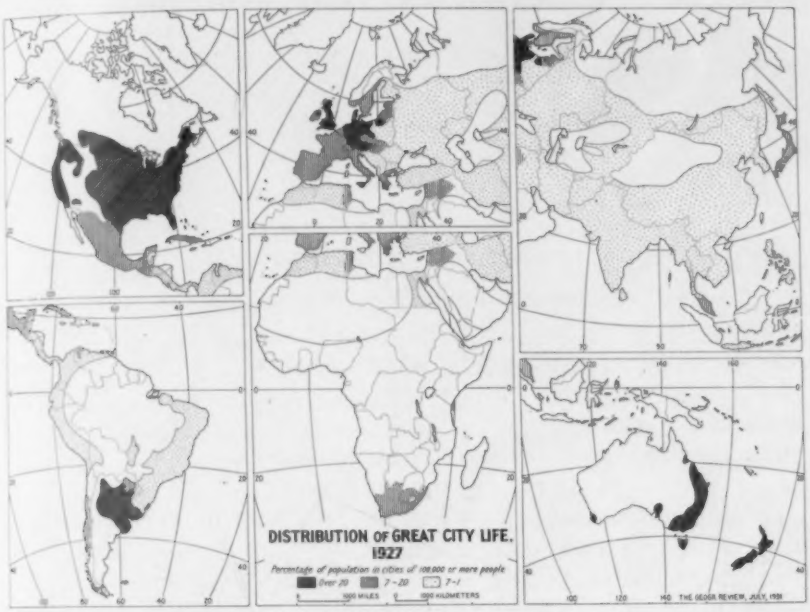

FIG. 1—Population in great cities. (Revised figures for Brazil give a percentage of 8.7.)

town or village character whatever, at least for most of their inhabitants. The only reports obtainable for the population of Spanish and Italian cities are for the communes that include them. The population assigned to Murcia in Spain, for instance, in the *Statesman's Year-Book* is the figure for the whole commune and is said to contain a very large proportion of purely rural people.

The Ukraine makes cities as small as 500 people, the United States now requires them to have 2500 (formerly 4000 and 8000), Belgium makes it 5000, Egypt in effect 11,000 and Japan 24,000. Other censuses take as urban the "dwellers in villages and towns" without more precise definition. The Argentine Republic leaves the decision to the local authorities. It should be mentioned too that Europeans do not accept the American notion that a city of any considerable size must be a seat of manufacturing industry. The late Antoine Vacher told the writer in 1911, when he was professor of geography at Rennes, that that town of some 70,000 people was not industrial, though admitting it had its "minor industries."

[1] In the article "Urbanization" in the latest edition (14th) of the Encyclopaedia Britannica.

Probably censuses differ so much in defining cities because their objects are political and national. The primary mandate is to ascertain the numbers of the inhabitants, their distribution and growth: the primary use, the reapportionment of representation when desired. Some distinction of rural from urban population by census takers was at once inevitable, and it is possible that special interest in

TABLE I—URBANIZATION BY CONTINENTS

CONTINENT	GREAT CITIES	MILLIONS		PERCENTAGE	CONTINENT	GREAT CITIES	MILLIONS		PERCENTAGE
		URBAN	TOTAL				URBAN	TOTAL	
Australasia	9	3.4	7.6	44.1	South America . . .	20	7.4	67	10.9
North America	90	38.1	156.8	24	Asia*	224	62.6	1180	5.3
Europe*	182	67.2	348.9	19.3	Africa	12	3.4	132	2.5
European America . .	90	39.4	139.2	28.3	European Africa . .	12	3.4	34.8	9.8
Indian America	20	6.2	85.2	7.2	Negro Africa	0	0	97.2	0
					World	537	182	1892.6	9.6

*All of Turkey and all of Russia are included with Asia and excluded from Europe.

separating out the rural folks has made them select very small units as cities, though their definition is usually of the urban folks. Rural people are those who do not live in "cities."

American usage seems to find intermediate social groups between rural and urban. Whatever the practice of the census, we do not call life in communities of two thousand or even ten thousand city life. American rural life is farm life, and villages and towns are thought of as occupying a middle ground between rural and urban.

FOUR REGIONS OF URBANIZATION

The writer wishes to compare the urbanization of different countries. In four widely dispersed regions of the world more than a fifth of the people live in cities of 100,000 or more. The regions are Australasia, North Sea Europe, northernmost America, and southernmost America. There are the most citified people in the world. In Germany, the Netherlands, Canada, the United States, the Argentine, and Uruguay one person in every four lives in a great city; in New Zealand and Austria one in every three; in England and Australia almost one in every two. Victoria, the southernmost state of Australia, has more than half its people in the one supercity, Melbourne; so has South Australia in Adelaide.

In four other separate regions, all like these in or near the temperate zone, from one in five to one in fourteen of the population

inhabit great cities—the rest of western Europe, Japan, Mexico, and South Africa. In tropical America, northern Africa, eastern Europe, and most of Asia from one in fourteen to one in a hundred of the population are great-city dwellers.

Large parts of Asia, North and South America, Africa, and Australia are almost uninhabited. Also lacking in urbanization, but for another reason are central Africa, where 97 million people are estimated to live, and most of the East Indies. These two regions are populous but have no great cities.

Beside the zonal arrangement two facts are obvious—the great city is essentially European in origin, and neighbor countries are similar in urbanization.

Great Cities of 100,000 or More People

The urban quality of life in cities of 100,000 people is unquestionable and is ascertainable. One can get the necessary data about cities of that size even in countries without a regular census. Moreover, the great-city growth that has characterized the last century was in cities of some such size. Cities of France, Germany, and the United States that may be graded as tiny, small, large, and great exhibited the following percentages of decennial increase:[2]

	Tiny	Small	Large	Great
France (1870–1890)	4½	9	21	18
Germany (1870–1890)	0	11	28	96
United States (1890–1910) . . .	27	36	44	47

All show a large growth for the great cities: agricultural France somewhat more for the large cities (20,000–100,000), industrial Germany and the United States very great for the great cities. In the United States the opening up of a new continent made even tiny places grow with vigor. But the great cities have done most of the growing.

In all the world there were in 1927[3] 537 of these great cities—182 in Europe (excluding Turkey and Russia), 224 in Asia (including all of Turkey and all of Russia), 90 in North America, 20 in South America, 12 in Africa, and 9 in Australasia. Australasia leads them all in urbanization with 44 per cent of its people in cities of over

[2] P. M. G. Meuriot: Des agglomérations urbaines de l'Europe contemporaine, Paris, 1898, p. 55, and U. S. Census.

[3] Statistics for earlier periods are given by Alexander Woeikof in "Verteilung der Bevölkerung auf der Erde unter dem Einfluss der Naturverhältnisse und der menschlichen Tätigkeit," *Petermanns Mitt.*, Vol. 52, 1906, pp. 241–251 and 265–270. See especially pp. 249–251 and the map, Plate 18. Adna F. Weber: The Growth of Cities in the Nineteenth Century (*Columbia Univ. Studies in Hist., Econ. and Public Law*, Vol. 11), New York, 1899, gives figures for cities of over 10,000 at 1800, 1850, and 1890.

100,000 people, North America comes next with 24 per cent, and Europe third with 19 per cent, while South America, Asia, and Africa tag a long way behind. Details are given in Table I.

That Australia is highly urbanized has long been known. It has been reported almost as a national defect. New Zealand is not far behind. Taken together as Australasia they lead the world in the tendency to city life.

Africa is at the other end of the scale, the least urbanized of all the continents; but the distribution of its great cities is peculiar. All twelve of them are in the extremities of the continent, in Morocco, Algeria, Tunis, Egypt,[4] and in South Africa, where white Europeans dominate in control of the land though making up only a small part of the population. These regions appear in the table as European Africa with nearly ten per cent of their total population in the great cities. More truly African are the 97.2 million negroes who live in central Africa and have no great cities. The central Africans seem to have felt less the influence of Europe than any other people in the world.

Somewhat similar is the low urbanization of medial, tropical America, where most of the people are of Indian or part Indian blood and the mean urbanization is 7.2 per cent. In the northern and southern parts of the American continent are Canada (25), the United States (28.8), and the Argentine Republic and Uruguay (26),[5] where European blood greatly predominates—140 million people who constitute European America of mean urbanization 28. The 85 millions of Indians and mestizos between are governed by a minority with more European blood, to whom their moderate urbanization is to be attributed, for they are found mostly in cities.

The assignment of Turkey and Russia to Asia is based on the difficulty of separating their European from their Asiatic domains while their urbanization (6½ and 6) is of Asiatic rather than European grade.

Table II gives the data for 67 countries: the total population, the urban population, and the urban percentage.

Some Special Cases

Recent disruption of old economic relations has produced some illusory or fictitious values. The Irish Free State has but one great city, Dublin. If the island be taken as a whole Belfast will be included, and the urbanization becomes 17.6 instead of 11, probably a better value. In spite of feelings of patriotic antagonism Belfast doubtless serves some urban needs of the parts of the Free State that are just

[4] Exception may be taken to Egypt as Europeanized, at least in early days when Alexandria and Cairo were already important.

[5] Chile (18), Cuba (16), and Paraguay (12½) are not far behind and might be included.

TABLE II—URBANIZATION BY COUNTRIES, 1927

COUNTRY	N	MILLIONS TOTAL	MILLIONS CITIES	U
Canada	7	9.40	2.32	24.7
United States	78	117.6	33.9	28.8
Cuba	1	3.58	0.58	16.2
Mexico	2	14.33	1.05	7.4
Guatemala	1	2	0.12	5.8
Salvador	1	1.69	0.10	5.9
Ot'er N. America	0	8.24	0	——
Colombia	1	5.90	0.17	2.8
Venezuela	1	3.03	0.14	4.5
Ecuador	1	1.56	0.10	6.4
Peru	2	6.15	0.22	3.6
Bolivia	1	2.97	0.14	4.8
Brazil	6	30.63	2.67	8.7
Paraguay	1	0.83	0.10	12.5
Chile	2	3.75	0.69	18.4
Argentine	4	10.40	2.68	25.8
Uruguay	1	1.76	0.45	25.5
Other S. America	0	0.49	0	——
U. S. S. R.	31	147.01	9.55	6.5
Turkey	2	13.66	0.83	6
Syria and Lebanon	2	2.05	0.31	15.5
Afghanistan	2	8	0.22	2.8
Iraq	1	2.85	0.25	8.9
Persia	3	9	0.63	7
India	35	318.94	8.21	2.2
Ceylon	1	4.50	0.24	5.4
Dutch East Indies	3	51.88	0.51	1
Indo-China	3	20.70	0.42	2.6
Philippines	1	10.31	0.29	2.7
Siam	1	9.21	0.39	4.3
China	112	480	30.88	6.4
Japan	21	62	8.72	14.1
Chosen	3	19.10	0.53	2.8
Taiwan	1	4.24	0.20	4.7
Straits Settlements	2	3.32	0.47	14.4
Other Asia	0	13.10	0	——
Sweden	3	6.04	0.82	13.6
Norway	2	2.8	0.36	13.0
Denmark	1	3.43	0.73	21.7
United Kingdom	42	45.28	20.01	44.2
Irish Free State	1	2.97	0.32	10.7
Belgium	4	7.93	1.45	18.3
France	17	40.74	6.31	15.5
Netherlands	6	7.62	2.09	27.5
Austria	3	6.53	2.11	(32.5)
Czechoslovakia	3	13.61	1.01	7.5
Hungary	3	8.52	1.20	14.2
Germany	46	63.18	16.81	26.6
Switzerland	4	3.99	0.59	14.8
Estonia	1	1.12	0.13	(11.3)
Finland	1	3.58	0.22	6.2)
Latvia	1	1.88	0.34	(18)
Poland	6	27.18	1.26	4.7
Italy	18	39.99	5.79	14.5
Portugal	2	6.07	0.84	13.9
Spain	9	22.44	2.77	12.4
Bulgaria	1	5.48	0.21	3.9
Greece	2	6.20	0.69	11.1
Rumania	2	8.63	0.42	4.9
Jugoslavia	3	12.02	0.48	4
Danzig	1	0.39	0.23	(59)
Other Europe	0	1.24	0	——
Morocco	2	5.30	0.26	4.8
Algeria	2	6.06	0.38	6.2
Tunis	1	2.16	0.19	8.5
Egypt	3	14.19	1.74	12.2
Union of South Africa	4	7.08	0.84	11.8
Central Africa	0	97.21	0	——
Australia	6	6.26	2.99	47.8
New Zealand	3	1.34	0.36	34.5

N is the number of great cities in the country, *U* the urbanization, or percentage living in great cities. The total and urban populations are given in millions. Bracketed numbers are for cities lately cut off from their economic countryside.

across the boundary. The Free State does fifty million dollars' worth of business with northern Ireland, which is twice as much as it does with the United States. The single decade that has elapsed since the Free State was established has not sufficed for the readjustment of city and countryside. Wherever old relations have been interrupted the result has more likely been straitened circumstances for individuals involved than the actual diminution of populations. Northern Ireland is both industrial and Scotch-Irish. On both counts its high urbanization was to be expected, but possibly not quite so high

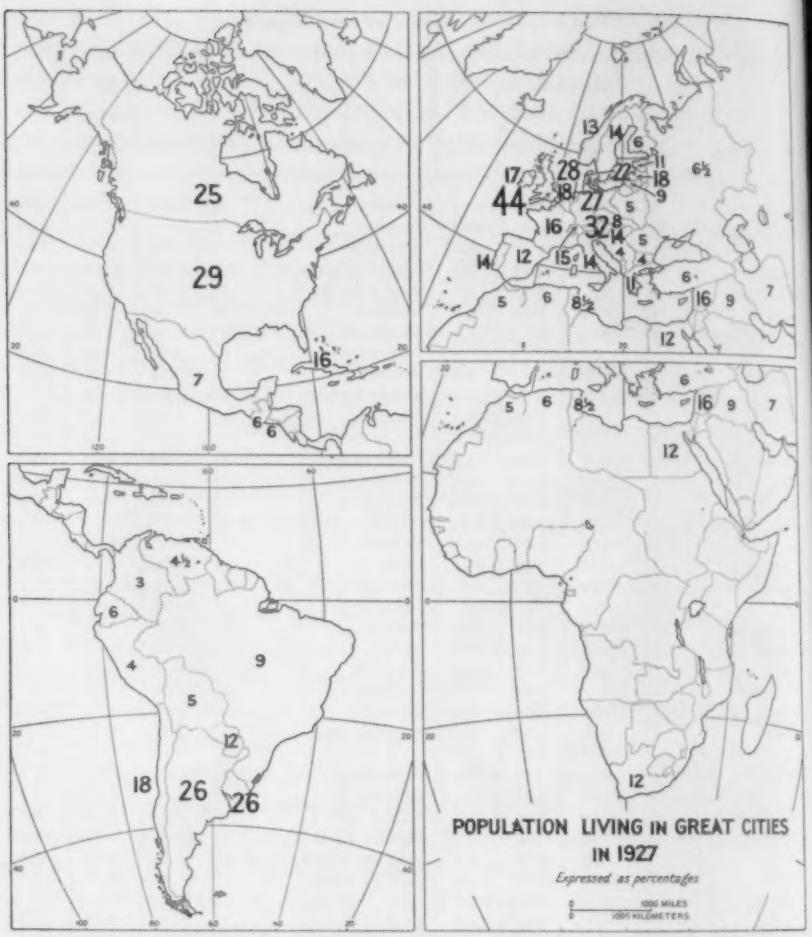

FIG. 2

as figured. Dublin under present politics has too much countryside, and Belfast probably not enough.

Distressing illustrations of the penalty of cutting cities away from their countryside are seen in the case of Danzig, the Baltic states, and Austria. The size of Vienna is out of all proportion to the present population of Austria. The Vienna of 1928 had 1,857,400, Austria 6,675,283. The old Austria-Hungary was a nation of 50 millions, and though Budapest was drawing near its million mark too, the present Austria is not the countryside that Vienna grew to million size in serving. That was made up of 30 to 40 millions from the inhabitants of the old empire. Taking the urban and total population of Austria, Hungary, Czechoslovakia, and Jugoslavia together for the present date, there are 4.8 million city dwellers in a region of 40.7 million people. The urbanization that results is 11.7, which is logical. It

is no figure of speech to say that before the war Vienna was imperial rather than Austrian. Vienna performed functions delegated to it by a much larger countryside than the Austrian one, drawing the most talented, the most capable, the most ambitious from far and near to the opportunities for life and work, with ever greater attraction as the city came to surpass all others in the region in size and wealth.

A million city cannot exist in isolation. It is a head office, as Aurousseau so brilliantly said of New York, of every important enterprise in its country, a heart to the national body. To wall off a supercity from its countryside involves much greater hardship than cutting it off from its food supply. Its work in life, that by which it earns its food, is taken away. Cities do not grow of themselves. Countrysides set them up to do tasks that must be performed in central places.

In the case of Danzig fifty-nine per cent of the inhabitants of the city state are reported from within the city limits. But this city grew in a long past out of the needs of a far wider countryside than was allowed it by the treaty makers. It came to be a city of 100,000 about 1878. In 1895, when Germany had a population of 52¼ millions, it had ten cities comparable to the present Danzig in size, of more than 200,000 each. That gave one Danzig-sized city for every 4½ million, if only the people in smaller places are counted—the kind of people Danzig had in its hinterland, leaving out the inhabitants of places larger than itself. These several millions in the countryside have been severed from the city which they had built for themselves, with the main result that the severed parts are unhappy. Some wormlike creatures may be able to grow into wholes when they are

cut in parts, but countries are higher organisms. Danzig is suffering from surgical shock, and new growth has not yet begun.

Much the same thing was done in creating the new Baltic states to the eastward. Estonia and Latvia have too large figures of urbanization, indicating too small a denominator in their fractions, too few people in their countryside. Riga's present nation of 1,880,000 do not make up the countryside out of whose needs the city of 378,000 grew up. There were three or four times that number of people in western Russia who used and needed Riga, if analogies mean anything, though the economic countryside of a great city is not easy to delimit or define. In the case of Riga, however, a new factor is introduced. Becoming a national capital it assumes new functions: for instance, it acquires its own university instead of being dependent on Dorpat, formerly the university center for the Baltic States. The city, in contrast to stagnant Vienna, has recovered the population lost in the war and is still gaining, in part at the expense of Libau.

Does the comparatively large urbanization figure for Syria also indicate too small countryside? The territory is Syria and Lebanon. Aleppo and Damascus are its cities. Syria alone with Aleppo would be reasonable, giving a percentage of 12½. But Lebanon does not cover the whole of the countryside of Damascus, which reaches far down into Arabia. Damascus grew up as the city of much of northern Arabia. Arab discontent is not so much due to French control as to the severance of ancient relations, with alien control of the city.

Singapore and Hongkong are cities in hands other than those of their countrysides, but there has been no dismembering here. The cities grew there to satisfy needs of aliens. The figure 14.4 gives an urbanization that is as excessive for the Straits Settlements as is 59 for Danzig. Hongkong would figure out at 51. Both grew up to satisfy the needs of the English, whose commercial enterprises demanded entrepôts and coaling stations in the Far East. Few of the inhabitants are Europeans. The cities grew because the English gave the natives better opportunities to market their wares and services than they had been able to make for themselves.

Regional Variation in Urbanization

In all large countries there is considerable variation in degree of urbanization. The average for the United States is 28.8;[6] but that in detail becomes 37 for the North, 30 for the West, and 13 for the South, or, removing the negroes from the denominator of the

[6] Interpolated from the census figures for 1920 (64 great cities, 105.7 millions people, 27.4 millions urban) and 1930 (85 great cities, 122.7 millions people, 36.7 millions urban).

The official number of great cities for 1930 was 92, from which seven have been subtracted—Cambridge and Somerville, really parts of Boston; Jersey City and Yonkers, really parts of New York; Camden, part of Philadelphia; Kansas City, Kan., part of Kansas City, Mo.; and St. Paul, one with Minneapolis.

fraction, 19. The negroes live in the white man's cities but build no cities for themselves. The South has always lacked the strong urge to cities that the North has shown.

Brazil, with territories a little larger than the United States, has even greater contrasts of urbanization, because it stretches from across the equator into the South Temperate Zone. The southern states—Rio Janeiro, São Paulo, Paraná, Santa Catharina, and Rio Grande do Sul—contain the largest cities, Rio, São Paulo, and Porto Alegre, with three quarters of Brazil's large-city population. More than 16 per cent of the inhabitants of these southern states live in the great cities, approximating conditions in Paraguay and Uruguay and putting southern Brazil into the second grade of urbanization of the map. That is the cultured end of Brazil. Northern, tropical Brazil is mostly peopled by Indians, negroes, and half-breeds. It has less than five per cent of its people in great cities.

Urbanization in Small Countries

If large countries are not homogeneous in degree of urbanization small ones do not find adequate expression of their urge to the city

	Total (in millions)	Urban
Sweden	6.04	0.465 Stockholm
		0.233 Göteborg
		0.117 Malmö
Denmark	3.43	0.730 Copenhagen
Norway	2.65	0.260 Oslo

in the great-cities percentages, as the total population is often not large enough to maintain any large city at all. In Germany, Britain, and the United States there is one great city for every million and a quarter or so people. Compare the case of Norway. In 1920 Norway had one great city, Oslo, giving a percentage urbanization of 9. Had another, Bergen, nearly of the critical size, the few thousands necessary to raise it to great-city size[7] urbanization would have been 13 per cent. Comparison with Sweden makes this seem more reasonable and it has been adopted in Table II. Norway, Sweden, and Denmark together would have an urbanization of 15.5, but it is probable that the larger figure for Denmark rests on a real difference.

Denmark's great city has nearly as many inhabitants as all three of the Swedish ones together, although Denmark has but half as many people as Sweden. One wonders whether Copenhagen has some of its countryside across the Sound in southern Sweden. The difference in language is slight. Denmark's trade with six million Swedes is

[7] The census of 1930 credits Bergen with 98,546.

nearly as large as that with 120 million Americans. Do the enterprising young men among the southern Swedes go up to Copenhagen to make their fortune? At any rate more than half the foreigners in Copenhagen are Swedes, and they number twenty thousand.

Function of the Supercity

This brings up the special cultural function of the supercity, the city of a million or more people and the things it alone can supply to its countryside. Six countries of Europe have million cities. The United Kingdom (45 millions) has 3; Germany (63 millions), 2; France (41 millions), 1; Poland (27 millions), 1; Hungary (8½ millions), 1; Austria (6½ millions), 1. If Copenhagen is not a million city today it is the nearest thing to it that Scandinavia has. Does its countryside extend beyond Danish lands? Does it exercise, in opportunities for wealth and power and culture, any of the charm that drew Scots like Carlyle, Irishmen like Shaw, and Welshmen like Lloyd George to London and that draws all talented and ambitious Frenchmen sooner or later to Paris?

Switzerland with four great cities, Bern (109,000), Geneva (127,000), Basel (142,000), and Zürich (215,000), doubtless finds Paris the cultural million city for its French-speaking southwest, Berlin for its German-speaking north, and Milan for its Italian-speaking south, though Milan still lacks something of million size. If a million city needs a nation of ten millions to maintain it, a little nation like Switzerland can have none of its own and must go beyond its borders to get or give, sell or buy those rare things that bring highest price, be they works of men or powers of soul or intellect. This is doubtless an opportunity for Swiss individuals and a loss to their country, since it tempts her most gifted sons to expatriate themselves. It is the special quality of the million city that, having gathered to itself energy and talent from every corner of its countryside and even beyond, it has available the services of these talents and energies. A million city outweighs ten cities of a hundred thousand as inevitably as a falling body outdistances in ten seconds the combined falls of ten that fall for a second each.

The Case of Belgium

Table III shows the Netherlands with an urbanization of 27 to Belgium's 18. Why should this be so? The two countries have about the same population and are similar in race and culture. Belgium has only four great cities, with less than a fifth of the Belgians in them; and the Netherlands have six, in which live more than a quarter of the Dutch. The war was a severe strain on Belgium. The Dutch cities all increased in population. Amsterdam, Rotterdam,

The Hague, and Utrecht were all great cities before the war, and now Haarlem and Groningen have come to 100,000 size. The war favored the Netherlands. But that does not explain the difference in urbanization, for it was substantially the same before the war: Belgium 17.4 and the Netherlands 23.8. Nor was it in great cities alone that the

TABLE III—COUNTRIES AND THEIR URBANIZATION IN THE ORDER OF THEIR RANK, 1927

*Danzig 59	*Austria 32.5	Argentine 25.8
Australia 48	§United States 28.8	Uruguay 25.5
United Kingdom 44.2	Netherlands 27.5	Canada 24.7
New Zealand 34.5	Germany 26.6	Denmark 21.7
Chile 18.4	*Straits Settlements . . 14.4	[Austria-Hungary . . . . 11.7]
Belgium 18.3	Hungary 14.2	*Estonia 11.3
*Latvia 18	Japan 14.1	Greece 11.1
[Ireland . . . . . 17]	Portugal 13.9	*Irish Free State 10.7
Cuba 16.2	Sweden 13.6	*Norway (1920) 9.1
France 15.5	§Norway* 13.0	Iraq 8.9
[Scandinavia . . . . . 15.5]	Paraguay 12.5	Brazil 8.7
*Syria and Lebanon . . . 15.5	Spain 12.4	Tunis 8.5
Switzerland 14.8	Egypt 12.2	Czechoslovakia 7.5
Italy 14.5	South Africa 11.8	Mexico 7.4
Persia 7	Ceylon 5.4	Bulgaria 3.9
U. S. S. R. 6.5	Rumania 4.9	Peru 3.6
China 6.4	Morocco 4.8	Afghanistan 2.8
Ecuador 6.4	Bolivia 4.8	Colombia 2.8
Finland 6.2	Poland 4.7	Chosen 2.8
Algeria 6.2	Taiwan 4.7	Philippines 2.7
Turkey 6	Venezuela 4.5	Indo-China 2.6
Salvador 5.9	Siam 4.3	India 2.2
Guatemala 5.8	Jugoslavia 4	Dutch East Indies . . . 1

*These figures have a fictitious value on account of political or other interference with normal development.

§Revised data not available in census statistics.

[ ]Regions not corresponding to present political entities.

Dutch had so high an urbanization. Belgium had 27 cities of more than 26,000 people with 29 per cent of the population of Belgium in them, and the Dutch had 36 such cities with 44 per cent of the Dutch population in them. There can be no doubt of the greater urbanization of the Netherlands. Is there any reason for it? One reason might be the greater commerce of the Dutch. They have five times as much merchant tonnage as the Belgians. But another reason certainly lies in a general peculiarity of census enumeration.

Sleeping places are so much easier to identify and count that censuses generally have come to identify a person with his sleeping place. If the United States Census could find a man who spent all his waking hours except transportation time in Philadelphia but slept every night in New York, it would count him as a resident of New York, though all that he contributed to the life of that city might be snores. Censuses, albeit unintentionally, concern themselves

with just that matter—how many sleep within a city's limits. But society asleep is not society any more than a cemetery is a social community. Society must be assumed to be awake. New York asleep—New York at 2 a. m.—is not what is meant by New York. It is certainly not the New York of 2 p. m., New York at work. The sleeping city may actually be of different component people than the city awake. To have any knowledge of a city that is worth while one must know how many pass their waking, working hours in it. The world's work is done by men awake, not by sleepers. Only the hotel and rooming-house keepers are concerned with the numbers who sleep in a town. For others the need is to know how many are there in the hours they are awake and doing. In 1800 this distinction was academic; few men then but slept in the same town where they worked. But modern means of transportation bring to the city every day swarms of workers who sleep outside. Their numbers may be very large.

Censuses of Cities Awake Needed

These considerations are so obvious that they seem hardly worth mention were it not for the misconceptions that arise from their neglect. Manhattan Island's population, it is said, has been decreasing since 1910. True for the sleepers, but is it true for those who work day by day? What do skyscrapers mean if not an enormous expansion of room for workers of every kind? All awake of course, except in the new skyscraper hotels. In 1910 it was said that 16,500 people, "five city blocks, with 500 city homes," were displaced to make room for the Pennsylvania station at 33rd St. But New York lost no population unless the frequenters of the station by day are fewer than the sleepers with their visitors turned out; and who cares if fewer people sleep there?

A striking diagram map by the Regional Plan of New York and its Environs claims a total of over 2,000,000 people entering Manhattan during 24 hours on a typical business day, 1924, and a succeeding diagram analyzes means of transporting this multitude![8] This explains why "the dot map of [night time] Manhattan appears pale in those portions of the city which, from the number of persons seen on the streets, one ordinarily thinks of as most congested."[9]

The 1915 Census of the Commonwealth of Massachusetts (p. 502) gives the daytime population of Boston proper as 845,054 with a nighttime population of 745,439.[10]

The 1921 census of England and Wales reported on "work places"

[8] Regional Survey of New York and its Environs, Vol. 4: Transit and Transportation, New York, 1928, pp. 36 and 37.

[9] *Ibid.*, Vol. 2: Population, Land Values and Government, New York, 1929, p. 75.

[10] Courtesy of Mr. Lester E. Klimm, University of Pennsylvania.

with some interesting data on the fluctuating city population.[11] The central City of London has 13,709 by night—the old official population—but 416,150 by day. It has long been a commonplace that pressure of population has been driving people out from the center of London, which had 129,128 people in 1851, 51,439 in 1881, and 26,909 in 1901. The City of Westminster, another of London's central districts, has 141,579 by night and 374,102 by day. That makes a total daily ebb and flow of 634,965 workers in the core of London.

Other instances might be given,[12] but only the case of Belgium will be dealt with. Demangeon[13] says "The country fields around the industrial region are still the residence of a part of the working population. The workers cling tight to their bit of land, to their garden, to their little stall, to their country hearth; they come back to it every evening. This tie between the land and the people of the workshops is kept intimate by the close and cheap network of communications that Belgium enjoys. The railways, especially the local lines, give a marvelous service to these country factory hands. . . . This abundance and stability of rural factory hands constitute one of the peculiarities and one of the superiorities of Belgian industry." It appears therefore that to the 1,450,000 sleepers (i. e. residents) in the four great cities of Belgium must be added all these factory hands who sleep in full country before a number is arrived at that is comparable to the 2,090,000 inhabitants reported for the more sedentary cities of the Netherlands. If these migrant workers added 300,000 to the resident population of the Belgian cities it would raise the Belgian urbanization to 24, more like the urbanization of the Netherlands.

If this explanation is correct and if unusual railway service made it possible for Belgians accounted rural by their census to do important work in the factories of Belgian cities, before the railways were so well developed in Belgium the present conditions could not have existed and city factory work must have been done by city residents.[14] That would give Belgium a higher relative rank in urbanization in earlier days than it has now. This is actually the fact. Whereas nowadays Belgian urbanization is 18.3, to a Dutch 27.5, in 1871 Belgium had 13.5 per cent of its people in great cities and the Netherlands only 11. Since then Belgium has increased her urbanization very steadily but at a rate much slower than the Netherlands.

[11] Census of England and Wales 1921: Workplaces, London, 1925; Census of England and Wales, 1921: County of London, Tables, Part III (Supplementary): Workplaces in London and Five Home Counties, London, 1923.

[12] See the note on Split elsewhere in this number of the *Geogr. Rev.*

[13] Albert Demangeon: Belgique, Pays-Bas, Luxembourg (Géographie Universelle, Vol. 2), Paris, 1927, p. 81.

[14] Émile Vandervelde (L'exode rural et le retour aux champs, Paris, 1903) says Belgian workmen get a six-day round-trip ticket for 31 miles for 44 cents (U S. money) while the ordinary single round trip costs 61 cents. Mahaim states that 43 per cent of the travelers on Belgian trains are such "workmen" and estimates that more than 325,000 workers hold these tickets.

To make that clear, the urbanization of eleven important countries has been ascertained through the last 50 years and platted on Figure 3. Belgium was more urban in 1871 than the Netherlands, the United States, Canada, or Germany but since then has fallen behind them all, its curve ascending so flatly as to cross all the others. If Belgium in reality had grown in daytime urbanization about at the same rate as the United States and Germany, that is if the daytime workers in Belgian cities had increased as fast as elsewhere between residents and commuters from outside, there would now be 29 per cent of the Belgians in their great cities—a result obtained by drawing the Belgian curve parallel to the others through the value for 1871. With the present population of the kingdom that would give for 1927 nearly 2,300,000 in the great cities, implying that 850,000 rural workers come to town each day—a very large number. It is unnecessarily large, for it neglects the circumstance that the families of city workers who sleep in the country are indeed rural in all their hours, waking as well as sleeping, while workers who sleep in town presumably have their families there.

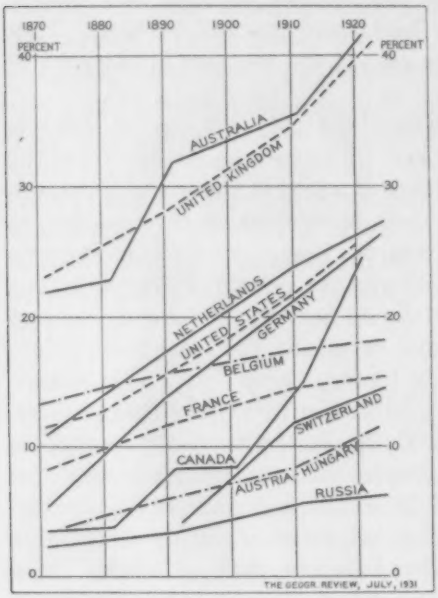

FIG. 3—The growing percentage of population in great cities.

The graphs bring out the fact that urbanization is everywhere growing with most interesting differences in the rate of growth. The kinks in lines, as in the case of Canada, are due to sudden entering of cities into the 100,000 size in countries that have few of them.

THE GROWTH OF URBANIZATION

The great cities are mostly new. In 1801 there were but twenty-one of them known by actual count in all the world, and all were in Europe.[15] At that time censuses were only just beginning. Italy claimed five great cities, France and Russia three each, the United Kingdom, Spain, and Germany each two, and Austria-Hungary, the Netherlands, Portugal, and Denmark each one. Now there are 182

[15] The census of 1793 in Mexico was admittedly defective. The figure of 112,926 given for Mexico City is generally considered to be too low. See *Bol. Inst. Nacl. de Geografía y Estadística*, Vol. 1, Mexico, 1861, pp. 10 *et seq.*

in Europe and 355 in other continents, that is two-thirds of all are outside of Europe. Urbanization is part of the Europeanization that is spreading through the world. Japan (1927) has 21 great cities. The United States has more of them than any other country except China, which has no census. The number of great cities in the world has doubled more than four times in the last 125 years.

At the beginning of the nineteenth century, when most census counts began, Europe already had nine ocean ports that were great cities—Amsterdam, Barcelona, Dublin, Lisbon, Marseilles, Naples, Palermo, St. Petersburg, and Venice. Furthermore, there were eight river ports of great-city size—London, Paris, Berlin, Vienna, Lyons, Rome, Moscow, and Warsaw. One might think Rome and Moscow not river ports at all, but such a scholar as J. G. Kohl believes that they came to be important just by the use that was made of their rivers by boats. Those were other days. And there were two cities in 1801 that are believed to have acquired their early importance as crossing point for roads on land. They were Milan and Madrid. Madrid had come to size about 1668, before real census taking had begun. Throughout the nineteenth century censuses enable us to plat the growth of each city and ascertain from its graph when first it reached the 100,000 mark. Of them 146, a third in the United States and two thirds in Europe, came of size between 1801 and 1900. These have all been placed on Table IV with dates in the margin, so that each city stands about in the place corresponding to its coming of great-city size.

American Great Cities

Up to 1804 there was no great city in the United States. There were none in the lifetime of Franklin or Washington. New York, which reached 100,000 in 1804, was for thirty-five years the only great city in the United States. In the year 1839 there came to great-city size three other towns—Baltimore, Boston, and New Orleans. Philadelphia joined them in 1842. All four were brought to this important size by their position as seaports. Probably at that time the commerce that exchanged American raw materials for the products of European factories was the only thing that could lift American cities to hundred thousand size. The rise of New Orleans points to the opening up of the interior world of the Mississippi Valley. From 1846 to 1869 there joined the list the four river ports of Cincinnati, St. Louis, Pittsburgh, and Louisville; from 1853 to 1877 the lake ports of Chicago, Buffalo, Cleveland, Detroit, and Milwaukee. With the exception of Washington, the capital, all the cities in the United States that have become great since that day have been railroad-made. In the last quarter of the nineteenth century the railways came to dominate the transportation of the country. After forty years of

TABLE IV—GREAT CITIES OF THE UNITED STATES IN THE NINETEENTH CENTURY
WITH DATE OF REACHING GREAT-CITY SIZE

	OCEAN	RIVER	LAKE	RAILWAY	OTHER
1804	New York				
1810					
1820					
1830					
1840	Baltimore Boston New Orleans				
1850	Philadelphia	Cincinnati			
1860		St. Louis	Chicago		
1870	San Francisco	Pittsburgh Louisville	Buffalo		Washington
1880	Providence?		Cleveland Detroit Milwaukee		
1890				Minneapolis Rochester Kansas City Omaha Indianapolis Denver Columbus Worcester Syracuse New Haven Paterson Los Angeles Scranton	
1900	Fall River?	Memphis?	Toledo?		

seaports America began to build railways. In the next half century use was made successively of river ports and lake ports, till the railway net was found complete enough to take up the country's work, a task now beginning to be taken over from them by motor vehicles on hard surfaced highways. As early as 1900 there was no town of ten thou-

TABLE IV—GREAT CITIES OF EUROPE IN THE NINETEENTH CENTURY
WITH DATE OF REACHING GREAT-CITY SIZE

OCEAN	RIVER	RAILWAY	OTHER	
				1800
Copenhagen	Hamburg			
Glasgow			Edinburgh	1810
Liverpool			Brussels	
			Manchester	
			Subotica	
			Birmingham	1820
	Seville			
	Prague		Leeds, Coventry	
			Bristol	1830
			Sheffield	
	Breslau			
Messina				1840
Bordeaux	Ghent		Munich	
	Dresden			
	Cologne, Budapest		Bradford	1850
Rouen, Belfast				
Antwerp, Stockholm	Rotterdam		Bucharest	
Nantes	Toulouse		Lille	
Newcastle			Elberfeld-Barmen	
Trieste			Salford	1860
		Bologna		
Genoa, Hull	Magdeburg	Lemberg		
Königsberg	Liége	Leipzig		
		Florence, St. Étienne		
Malaga		Hannover		
Dundee		Yarkand		
Odessa		Leicester, Hague		1870
Plymouth	Frankfort am Main	Nottingham		
Christiania	Gratz	Stuttgart, Nürnberg		
Oporto, Riga, Aberdeen		Oldham		
Brighton, Bremen		Bolton, Blackburn		
Catania, Danzig	Düsseldorf	Chemnitz, Kishinev		
Le Havre, Stettin	Strasbourg			1880
Salonica, Leghorn				
Cardiff		Tula, Brunswick		
Preston	Saratov	Reims, Aachen		
Göteborg	Kazan	Halle, Turin, Lodz		
Athens, Astrakhan		Zürich, Norwich, Brünn		
		Vilna, Dortmund, Krefeld		
		Essen, Geneva, Kassel		1890
Murcia		Derby, Zaragoza		
Swansea, Kiel	Mannheim	Szeged		
	Samara, Basel			
	Utrecht			1900

sand people in the United States that was not on a railway. Incidentally, about 1880 the period of vigorous homesteading came to an end. In other words, the development of great cities ran parallel with the exploitation of the national domain.

Nothing similar is to be perceived in Europe. There rivers, canals,

and highways had been pretty well developed before the railway came. Europe had very effectively engineered transportation when America had nothing but the ocean and natural watercourses. Neither roads nor rivers in America were ever well developed for use as Europe understood the matter. As settlement advanced into the West much use was made of the natural waterways of a few great streams just as is done to this day among the peoples called backward, those who have not made better agencies of transportation for themselves; but when once the railways advanced beyond the stage of feeding and complementing ocean and river traffic, as they did distinctly in 1850, and became a continuous net, they superseded the river traffic almost completely and put off the era of road building until it received the stimulus of the privately owned internal combustion motor at the beginning of the twentieth century. In Europe, when the railways came, they merely replaced some part of the means of transportation that were already very effective. But, while river cities long preceded ocean ports in active use because the paths of ocean seemed hazardous to early men, the returns from sea voyages were so profitable that as soon as Atlantic navigation was established the ocean cities grew to unprecedented wealth and size.

Among American cities San Francisco must be regarded as an outgrowth of California gold discoveries rather than of ocean traffic; and, though Providence and Fall River both have access to the sea, it was railway traffic and not sea-borne trade that developed them to hundred thousand size. In 1901 Providence handled but a twentieth of one per cent of the nation's foreign commerce, Fall River but a two hundredth of one per cent. San Francisco handled four per cent. The four older ports handled 72. Memphis is included among the river ports merely because it stands on the Mississippi, which is not a sufficient reason. It was undoubtedly railway traffic that brought it up to great-city size in 1899. A similar suspicion holds for Toledo on Lake Erie (1891). If these five doubtful cases be omitted, the table of American cities becomes very significant: five ocean ports, four river ports, five lake ports, and twelve railway cities taking up the burden of American transportation in succession.

European Cities

After Copenhagen and Hamburg in 1801 and Glasgow and Liverpool in 1809 and 1811 no European ocean city reached great-city size for twenty-nine years. In America the period had lasted thirty-five years, but there the likeness ends. The United States closed its family of great ocean ports with the early ones that are still carrying 69 per cent of her commerce on the seas, but in Europe new great cities have appeared by the sea in rapid succession ever since 1850. To

its nine eighteenth-century ports four were added in the earlier part of the nineteenth century, but no less than thirty-five in the last half, a period in which the young and rapidly expanding United States received only the three just discredited. The thirty-five new ports were in twelve different countries. Doubtless patriotic ambition was operative in each country, a stimulus lacking in the United States; but it is also true that Europe is naturally divided into a variety of physical regions and that the sea penetrates astonishingly into the continent.

River transportation in Europe is not only ancient but is still much used. To the eight river ports of 1801 eight more were added in the first half of the century and seven in the second half: water-borne freight is still of importance in Europe.

Of the third group of cities, those originating on road crossings, Madrid and Milan, were of size in 1800. Fourteen other road towns rose between 1800 and 1860. The United States has never had a single one. Until recently she had no roads at all. When Minneapolis-St. Paul first had 100,000 people in 1881 there was no difficulty in deciding that it was a railway city. It had its river, but the railway carried almost all its freight. In Europe, with the long succession of highway towns, it is not so easy to decide which was the first to receive its main impetus to great-city growth from railways rather than from roads. One must select the first railway city for Europe with attention to the expansion of the railway net. Possibly Munich, but more likely Bologna, was the first great city of the railway era in Europe. In the second half of the century thirty-five more were added. At the century end they dominated transportation in Europe almost as in America.

But what is the significance for geography of this dominance of the railways in nineteenth-century transportation? Countries, i. e. populations of men more or less hampered by the restrictions of national boundaries and national prohibitions, have been developing a nucleation into town and city dwellers as well as a widespread body of tillers of the soil, the rural people who have been the basis of life throughout the age of civilization. The nucleation takes place by concentrating important markets and delegating country needs for tools, machines, and fabricated wares, the production of which seems to have been taken away from country dwellers and established in cities. This concentration and nucleation has created towns and cities, has used and improved means of transportation, and in the nineteenth century took on a great expansion through the use of steam railroads. Population is not twofold, urban and rural, but one, nucleated by railway transportation into towns and cities among country folks. Urbanization is the process of nucleation that concerns the great cities.

DOMESTIC AND MUNICIPAL WATERWORKS IN ANCIENT MEDITERRANEAN LANDS

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THE long summer drought made the presence of water a controlling factor in the distribution of population in the ancient Mediterranean lands. It determined both the size and location of the rural community, wherever irrigation made a drain on the local water. The scarcity of unfailing streams emphasized the importance of perennial springs or wells. Where these were numerous the villages were generally numerous and small; population broke up into small groups, with their farm lands conveniently near. But where the springs were sparsely scattered, population had to concentrate about them in fewer groups, no matter how long might be the way from home village to outlying fields.

Importance in the Region at Large

The growth of large and populous cities became possible only after the development of a complete technique of waterworks, which utilized water from local sources and also introduced it from distant springs, rivers, or lakes. The construction of such works depended also upon the concentration of urban wealth. Impressive waterworks appeared first in ancient seaports with profitable maritime commerce like Samos, Cnossus, Athens, and Megara; or ancient capitals like Jerusalem, Corinth, Carthage, and Rome; or active local markets like valley towns of the Apennines or the Atlas Mountains. This waterworks construction was stimulated by the requirements of municipal and private baths, made almost imperative for health and comfort in the hot, dry summers. Moreover, the ancients recognized the connection between water famine and pestilence. Virgil vividly describes their operation in Crete.

All ancient literatures reflect the concern of the Mediterranean people to secure a pure and ample domestic water supply. Aristotle says: "There should be a natural abundance of springs and fountains in the town; or, lacking these, large reservoirs may be established for the collection of rain water, such as will not fail when the inhabitants are cut off from the country by war . . . if the water supply is not all equally good, the drinking water ought to be separated from that used for other purposes."

To protect the water against pollution and theft heavy punishments and fines were imposed in Greece and Italy. Furthermore, the Roman plutocrats had their drinking water first boiled and then chilled by mountain snows; if the snow was not clean, it was strained through fine linen cloths. In this they imitated the practice of Cyrus the Persian who on his campaigns took his drinking water with him from Susa, boiled and carried in silver vessels.

As to the sources of drinking water, all authorities commend spring water and rain water conducted to a reservoir in earthenware pipes, as opposed to water from muddy streams or stagnant pools and marshes. Columella gave a second place to mountain streams tumbling over rocks. He agrees with Hippocrates the great physician, who preferred water "flowing from high ground and hills, sweet and clear" and water derived from deep wells.

From Palestine to Spain the "fountain of living water" was the great desideratum. The spring was the nucleus of town and village life, the starting point around which the community grew up, like the Virgin's Spring in Nazareth. In Greece also, to the mind of the native, it became identified with his home town. When Theognis of Megara (d. about 540 B. C.), disgusted because a political upheaval dislodged the oligarchs and placed the common people in power, decided to become a voluntary exile, he expressed his purpose in terms of his native spring:

> The years I dropped my pitcher in the clear dark village spring
> How sweet and good the water's taste did seem.
> But now the rains have flooded it, the mountain streams have muddied it,
> I'll drink another spring, a larger stream.

About the village spring or its reservoir the women gathered in the twilight, water jars on their shoulders, as they may be seen today in Nazareth or some hamlet in the Apennines, to linger and gossip. Here at all hours the men resorted to discuss local affairs and advertise matter of local concern. The importance of the town spring or pool is reflected in the care Pausanias takes to mention its name, its site, its mountain or piedmont source; and, if its water has been brought from a distance, he tells who installed the conduit. He does this for all the ancient Hellenic world from Antioch and Asia Minor to Syracuse with its Fountain of Arethusa. He includes even a village like Pyrrhichus near Cape Malea, whose sole water supply was provided by a conduit built by the demigod Silenus from a distant spring to the market place. Many of the springs have a mythological or miraculous origin, like the Dirce Spring of Thebes; or the conduit from mountain to city is attributed to the legendary founder of the colony, like the aqueduct to the Theban Cadmeia from the Cithaeron Mountains. In any event it is identified with the

beginning of the city. The Fountain of Priene, the famous spring of Corinth, shows five building periods in its well house, which dates from the sixth century B. C.

West of the Jordan

Conditions in Palestine and Syria favored an individual rather than a community water supply. "Drink waters out of thine own cistern, and running waters out of thine own well," says the Hebrew proverb. Better still was a spring, or "fountain of living water," for cisterns hewn from the limestone rock might leak through natural clefts. Often the spring in the limestone country was underground, reached by a well shaft; where the flow was very abundant, such a spring or well was sure to have a whole village or town grow up about it. Such is the Virgin's Spring of Nazareth, sole water supply of the town today as in the boyhood of Christ. The numerous place names in Palestine beginning with *En* or *Ain*, meaning spring, point to the water supply as the determining factor in locating a town or village.

The coastal plain of Palestine and Syria was supplied by the "fountainheads," or springs, that burst forth near the base of the Judean and Lebanon highlands; and also by wells sunk to the ground water. In the Philistine plain the ground water rose near the surface and supplied the ample wells of Gaza and Ashdod; but on the steep coast of Lebanon where the ground water has a rapid run-off, the ancient Phoenicians probably placed their chief reliance upon mountain streams and springs. The authorities give meager material on this point, though the Phoenicians were famous throughout the Mediterranean region as hydraulic engineers. Only Strabo reports the ingenuity of the island city of Aradus in achieving a water supply. Rain water from the roofs was stored in cisterns; and in addition a submarine spring, which welled up in the sea a few hundred yards from the port, was tapped by sinking over it a great inverted funnel with a hose attached.

Springs are copious and numerous along the western escarpment of the Judean Plateau but shrink rapidly in size and number in the rain shadow to the east. The pastoral region of the Negeb to the south has always been a transition belt physically and climatically between the Judean Plateau with its moderate winter rains and the Desert of Paran. The few springs and wells of the Negeb were essential for field or herd. Even Debir, near the northern margin of Hebron, was scarcely habitable without springs. Isaac, who occupied the southern district, kept close to the well of Lahai-roi. Wells sunk in the dry wadi beds were private possessions fought over by the rival herdsmen of Abraham and the neighboring king of Gerar. The

Philistine sheik filled up the wells, using an ancient method of maintaining a waste boundary to exclude encroachments of neighboring nomads. It was employed also as a punitive measure by the kings of Judah and Israel when they invaded the Moabite country east of the Dead Sea.

The cities of Palestine, with their concentrated populations, felt the need of exploiting all local resources to assure their water supply. As walled towns, subjected to siege in a warlike age, they were peculiarly dependent upon the water supply of summer, because campaigns were generally made in this season. While each house had a cistern to store the rain water from its own roof, the city provided public pools or reservoirs formed by damming a valley stream; in many cases these were supplemented by aqueducts from distant springs. Pools acted as settling tanks and were often connected with public baths. In this case they were surrounded by porticos where the bathers rested or lounged, protected from the sun. The Pool of Siloam at Jerusalem had four such porticos, whose remains have been excavated, and the Pool of Bethesda had five, one of them running across the middle of the basin and dividing it into two parts. Besides Siloam and Bethesda, Jerusalem had its Upper Pool, its Lower Pool, the King's Pool, Old Pool, and Hezekiah's Pool. Josephus mentions also four others existing in the city at the time of the Roman conquest. The Pools of Solomon, three large reservoirs ranging from one to two acres in area, may be seen today beyond Bethlehem eight miles from the ancient capital. They are possibly the "pools of water" made by Solomon to irrigate the gardens and orchards of his summer palace; but their water was conveyed to Jerusalem by a very ancient conduit, over thirteen miles long, which tunnels the hill of Bethlehem. The Pool of Siloam was fed in part by a tunnel conduit which brought water from the Fountain of the Virgin and which, from an inscription on it in Phoenician characters, must date from the eighth century before the Christian era or even earlier. King Hezekiah dammed the upper watercourse of Gihon and brought the water by conduit to his Pool in the west side of the city of David. The channels were largely hewn in the rock and were always covered with stone slabs to keep the water pure and reduce evaporation.

Other towns also had their pools, like Gibeon, located ten miles northwest of Jerusalem and famous for its "high place" where Solomon worshipped; Hebron, near the summit of the Judean Plateau where two ancient reservoirs survive, one 132 feet square. On the arid eastern escarpment of the Judean Plateau, tanks and aqueducts fed by limestone springs supplied water to cities like Jericho and Bethshan. Herod built reservoirs on a large scale to impound the local spring water in the citadel of Macherus, a natural fortress on a high headland overlooking the Dead Sea; and he also built rock-hewn cisterns in

Masada, as Josephus has described, when he began to fortify the frontiers of his kingdom.

On the Desert's Edge

Across Jordan, on the westward-facing escarpment of the plateau of Arabia, poverty of water necessitated its early conservation wherever towns grew up along the ancient highway from the Red Sea north to Damascus and the great bend of the Euphrates. The Moabite capital of Heshbon, an important place when Moses traveled towards Canaan, had a pool fed by springs or streams from Mt. Pisgah and famous for its beauty. The ruins of a tank at Heshbon show it to have been 191 feet long, 139 feet broad, and 10 feet deep. Mesha, King of the Moabites in the time of Jehoshaphat, according to the famous Moabite Stone built reservoirs for Baalmeon and other cities of this plateau. Madeba, which existed in Mesha's time, now shows the ruins of a pool which measures nearly three acres.

Owing to the incursions of desert tribes on the western edge of the Syrian Desert, extensive water works had to wait for the rule of the Romans and were therefore chiefly of Roman construction; but in some instances the Roman and earlier native works lay side by side. Petra is an example. Known to the ancient Hebrews as Sela, or the Rock, it was the capital of Edom when that country was conquered by King Amaziah of Judea; but it began to attain importance as a desert market under the Nabateans about 100 B. C. and reached preëminence only after the Roman conquest. Located on an arid plateau 3000 feet high, south of the Dead Sea, it depended on ancient aqueducts from springs two miles up the Wadi Musa Valley above the town. The earliest conduits were cut in the soft sandstone of the wadi walls, far above the stream; but the later Roman aqueducts of clay pipe were let into the opposite face of the cliff and secured by cement. The "high places" also about the city were provided with small rock-hewn pools which doubtless figured in the primitive ceremonies to rain-giving Baal. An extensive system of channels and small tanks for gathering the rain water equipped the long canyon approach to one of these "high places" for the benefit of thirsty pilgrims in the dry season. These undoubtedly belonged to the earliest period of the city's life. Strabo tells us that in his time Petra derived from its springs enough water for domestic use and for the city gardens but that the country about was for the most part desert. These conditions point to careful exploitation of the local water supply.

Despite these provisions for a regular water supply, there were times when successive years of diminished rainfall encroached upon the narrow margin of moisture; when men scoured the country for

the last surviving trickle from some hidden spring; and when the hart indeed panted after the water brooks, which had become beds of gravel. Then Isaiah's promise to the righteous man, "Bread shall be given him; his waters shall be sure," guaranteed something more than the commonplace. The Hebrew proverb "Stolen waters are sweet" testifies to the fierce thirst that prompted the petty theft rather than to a fictitious zest lent by an unlawful act. The scriptures abound in instances of water miraculously supplied, generally in the "wilderness" or desert borders but occasionally also on the Judean Plateau and even on the wooded slopes of Mt. Carmel.

All the region on the fringe of the Syrian Desert, from Palmyra to Petra, offered sites for settlement only where oasis conditions existed; where rare perennial streams like the Jabbok, Yarmuk, and "the rivers of Damascus" offered an unfailing though variable water supply; or where water from distant wadi or springs could be brought by aqueduct or underground conduit to reservoirs in the town. The copious streams that flowed from the Anti-Lebanon range and Hermon to the oasis of Damascus guaranteed that city a natural water supply. Elsewhere the human task was vastly greater, and the accomplished work more easily jeopardized. Palmyra is described by Pliny as located "in a region that all around in a vast circle is a sand desert and separated by nature from other lands" yet famous for its fertile soil and pleasant water brought in covered aqueducts and stored in reservoirs. Palmyra, first mentioned in 41 B. C. and flourishing in the imperial period of Rome, owed the security of its water works to the partial protection of the Romans, whose trade the city forwarded to the Euphrates.

The remains of all the highland cities of eastern Syria show the ruins of Roman aqueducts, baths, reservoirs, and occasionally a *naumachia*, or naval pool, like that at Gerasa. Gadara, which lay on the route from Esdraelon to Canatha and the Hauran, occupied an admirable fortress site on an important highway but had to depend on cisterns and a meager spring till the Romans built it a thirty-mile aqueduct. Their engineers also exploited the streams of the Hauran Mountains, whose great massif, 6032 feet high, condensed abundant winter rains and supplied water to Canatha, Bostra, Philippopolis, and the three hundred villages skirting the slopes.

Other towns of Gilead and Bashan whose history extends back to legendary days relied on cisterns, rock-hewn reservoirs, and wells, whose remains can be seen today amid the later remains of Roman baths and aqueducts. The ancient capital, Rabbath Ammon, rebuilt by Ptolemy Philadelphus and later improved by the Romans, depended during the siege of the city by Antiochus (218 B. C.) upon an underground passage giving access to one of the many deep reservoirs that were utilized by the natives in periods of danger.

Hellenic Concern over Water Supply

The Hellenic cities show equal concern for their water supply and a high regard for springs, to which they often attributed great sanctity or a miraculous origin, probably as a method of social control to protect the water supply against pollution. Many of them sacred to Apollo and Demeter, divinities of agriculture, suggest the utilization of their waters for irrigation. Others issued from sacred groves, which probably owed their sanctity as well as their trees to the god-given waters. Others rising in caves made the grottos holy places, shrines of gods or abodes of nymphs. In the summer droughts the undiscouraged flow of some rocky fountain must have seemed to the thirsty a perennial miracle. One hears the wayfarer exclaim with Pindar, "Water is best of all." In modern Greece the good-by wish to the departing guest is: "A safe journey and fresh water."

Springs, of paramount importance to the ancient Greek cities, provided the first local water supply. City springs meet us in Homer, in the fountain of Hyperia in Pegasae on the Gulf of Volo, by the roadside in the city of Alcinous, and in the Fountain of Arethusa in the capital of Ithaca. The last became famous; its name reappeared in the city spring of Euboean Chalcis and also in Syracuse. The Greek tyrants justified their beneficent despotisms by improving the water supply of their respective capitals. Pisistratus (605? to 527 B. C.) adorned the chief spring of Athens with a hall of columns where the water issued from nine jets, giving it the name of Enneacrunus, or fount of nine mouths. Water was brought for it by two conduits from the upper course of the River Ilissus, one of them passing underground out to the Piraeus. Other aqueducts, one from Mt. Hymettus and two from Lycabettus, contributed to the water supply of Athens, while a system of canals from the Cephissus irrigated the neighboring olive groves and gardens. The Greek conduits were generally subterranean channels cut in the natural rock. To keep them safe and clean, shafts were sunk at intervals, admitting light and air. At the entrance to Athens the aqueducts discharged their water into rock basins for settling before distribution through the city. When necessary, conduits pierced the hills by means of tunnels, as in Palestine.

Megara had its waterworks in the form of a long canal, built by the tyrant Theagenes in 620 B. C., which brought water from the mountains to a beautiful basin in the market place, famous for its size and decorations. Polycrates of Samos, about 530 B. C., employed the leading hydraulic engineer of his time, a native of Megara, to supply Samos city with water. The need was crucial for a big town on a small island, which, however, had a high mountain core. The task was accomplished by piercing the mountain by a tunnel nearly

a mile long to reach the springs of Mt. Ampelus. Thence water was distributed to the wells, pipes, and baths of the city, while the surplus went to cleanse the sewers. Corinth had the most famous city fountain of all Greece. The upper spring, located in its high rock citadel, was said to be the gift of the river god Asopus. So precious a boon on that bare rock could be explained only by a divine origin. The lower Priene spring has an elaborate well house. The colonnade over the basin and the bronze lion heads from which the water flowed are still to be seen.

More elaborate even than anything that democratic Greece could show were the waterworks and drainage system in the royal palaces of Crete, a thousand years before the time of the Greek tyrants. The palace of Cnossus had lavatories and sinks equipped with terra cotta pipes and drains of stone or cement. That of Phaestos had bathrooms well constructed and amply equipped. The water was probably brought in artificial channels from the high mountain range that forms the backbone of the island. These works antedated the Hellenic invasion of Greece and may have furnished the models for the later water systems. The widespread development of hydraulic engineering, however, must have been due to the need of irrigation as well as that of a reliable domestic water supply. The finest Greek aqueducts were the underground conduits of Syracuse, which brought drinking water to the city. These were destroyed by the besieging Athenian forces in 413 B. C. But Syracuse was not the only city so supplied. The victor of the Olympic Games in 452 B. C., returning to his native Camarina in Sicily, praises "the River Oanis and the lake of his native land, and the sacred channels wherethrough doth Hipparis give waters to the people."

Roman Developments

The Greek colonies located about the Bay of Naples may have given the first impulse to the utilization of the hot springs there for public baths and the consequent installation of the waterworks that supplied these baths and the fountains and fishponds in the private gardens of Herculaneum, Pompeii, and Cumae. But the city of Rome, heir to the hydraulic science of the Mediterranean Basin and desirous of providing water for its large population, shows the most extensive waterworks. The report of Sextus Julius Frontinus, water commissioner of Rome in 97 A. D., gives a complete survey of its system. The nine Roman aqueducts were carried mostly underground for safety in time of war. They crossed valleys on high arches. The Appian aqueduct, brought to the city in 313 B. C., was more than ten miles long and had its intake at a spring on the estate of Lucullus. The Marcian was sixty miles long and had its source in the Sabine

Mountains "where countless springs gush forth from caves in the rocks." Such springs were sought out, opened up to get an ampler flow of water, and then walled in with concrete to keep the source intact. The old Anio aqueduct, built in 273 B. C., came from the Anio River above Tibur, forty miles distant. Its water was often muddy during the winter rains, as was that of the New Anio conduit till a settling tank was built.

Rigid distinction was made between pure and impure water by the Roman water commissioner. The supply from the Alsietina duct was drawn from a lake, none too clean; hence it was not distributed to the public but was reserved for the Naumachia, the naval lake of the Caesars, or for irrigating gardens. The spring-fed aqueducts were considered the best, and these were reserved for drinking water. The water system of Rome supplied private houses, the 39 ornamental fountains of the city, and 75 public structures, chiefly baths, like those of Nero and of Caracalla. Gardens in and about the city also were supplied with water.

Fraudulent tapping of the public aqueducts and reservoirs was rife from early times. Illicit pipes were laid by the thieves, and the robbery was connived at by the watermen. Landed proprietors having estates along the course of the aqueducts tapped them to water their gardens. Frontinus, when appointed commissioner, made a survey of the city's water supply and rounded up the delinquents.

The attribution of curative power to various pools and fountains and even rivers permeates ancient Mediterranean life. The healing power of hot springs was recognized and exaggerated in Italy, especially in the volcanic regions, where the baths of Baiae and Naples became famous.

Commensurate with the importance of springs under Mediterranean climatic conditions and their large number wherever limestone predominated, an elaborate fountain architecture developed which set the standard for later times. This was especially varied and beautiful in the gardens and peristyles. It was stimulated also by the custom of erecting a nymphaeum, or temple, above the spring where it issued from the mountain source.

Finally, Rome instituted the Fontinalia, a religious festival in which garlands were thrown into all the city fountains of Italy and the god Fons appeared with the goddess Flora to secure abundant water.

THE DEVELOPMENT OF DRAINAGE SYSTEMS: A SYNOPTIC VIEW*

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PHYSICAL geography has a dual nature.[1] It includes a static or passive phase involving the detailed form of the land surfaces and a dynamic or active phase involving the agents and processes modifying those surfaces. The first of these phases is known commonly as geomorphology; the second might well be called surficial geodynamics.

The present work desires to confine its attention to streams. It is the purpose of the paper to trace in a summary manner the sequence of pattern during the development of a drainage system after a fashion as nearly ideal as possible for a region of simple rock structure and of humid climate. The following treatment has no intention or wish to ignore the influence of rock and structure nor has it the desire to minimize the fascination in the study of land forms. It does, however, intend to adopt the dynamic viewpoint for the time being.

The sequential stages recognized in the evolution of a drainage system are "extension" and "integration": the first, a stage of increasing complexity; the second, of simplification. The assumption that extension begins on a "new" land surface will be entertained for the present.

The Stage of Extension

Extension may be held to include the genesis (initiation) of streams and thereby the birth of a drainage system, the headward growth (elongation) of the new streams into virgin territory theirs by right of inheritance, and the constant addition (elaboration) of tributaries of decreasing rank up to the time when the system is fully developed from the standpoint of drainage. The form of the drainage system assumed at initiation, which constitutes the first step in the establishment of the system, largely determines the general pattern of the drainage during the early phases of growth. The initial phase of

*A summary of parts of a paper presented before the Geological Society of America, Washington, D. C., December 28, 1929. The writer wishes to acknowledge his obligation to the Department of Geological Sciences at Yale University where the investigation into drainage systems was initiated, to the Research Committee of the Graduate School of Ohio State University for a grant of funds which made possible the continuation of the work, to the University's Department of Geology for many valuable favors, and to all three organizations for constant encouragement and material assistance.

[1] Waldo S. Glock: Dual Nature of Physiography, *Science*, No. 1853, Vol. 72, 1930, July 4, pp. 3–5.

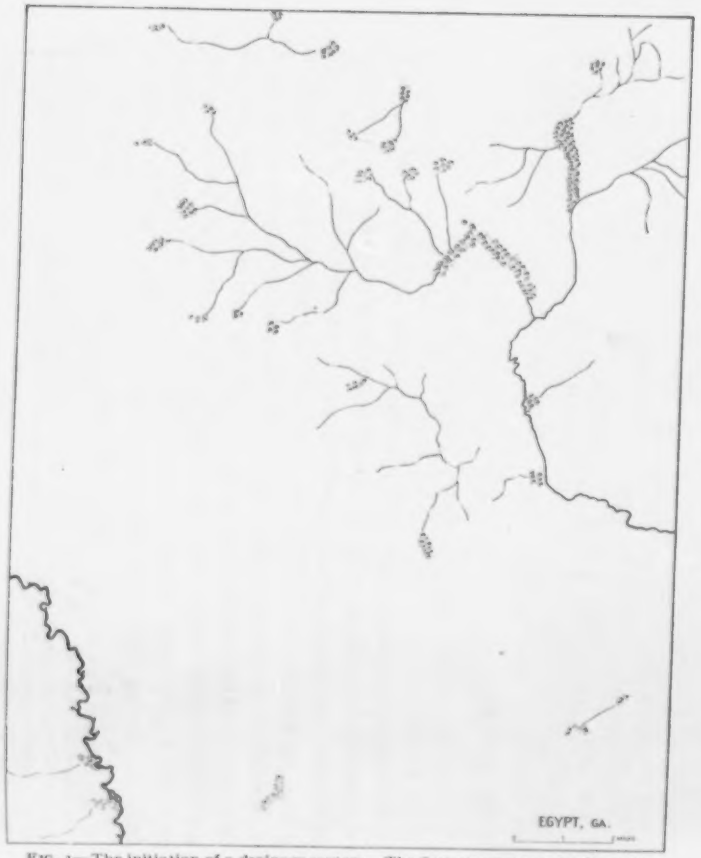

FIG. 1—The initiation of a drainage system. The first attempts at the formation of definite drainage courses, hence the very beginning of extension.

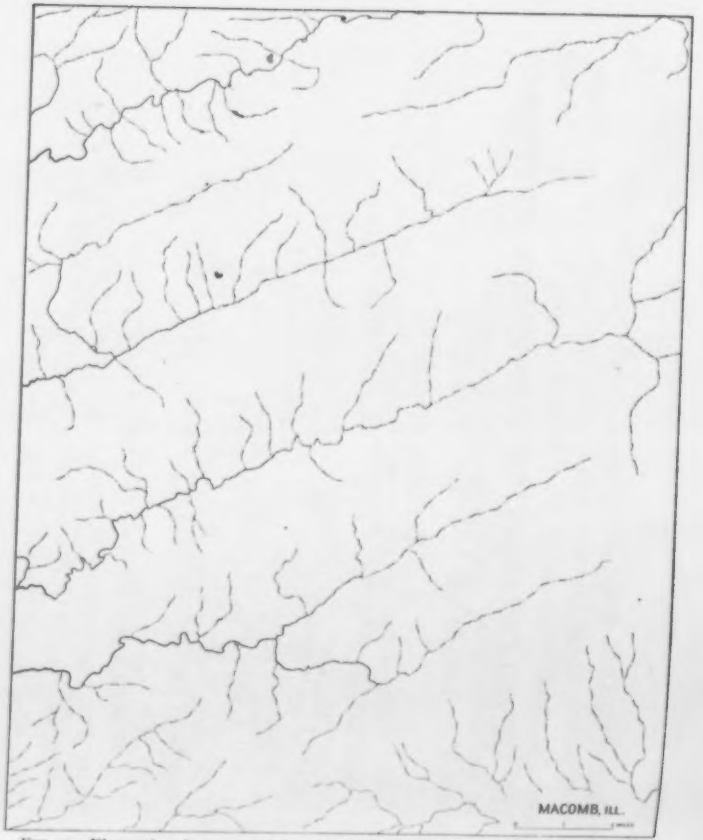

FIG. 2—Elongation is very nearly, or quite, complete, and the framework of the system has been established. In contrast, elaboration has just begun.

FIG. 1—The initiation of a drainage system. The first attempts at the formation of definite drainage courses, hence the very beginning of extension.

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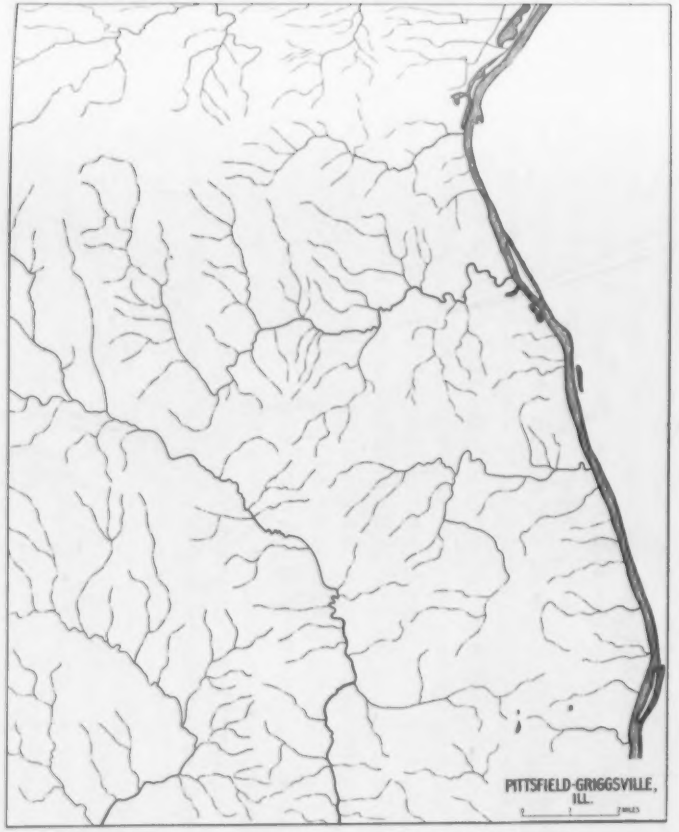

FIG. 3—The progress of elaboration, or filling in, is clearly evident.

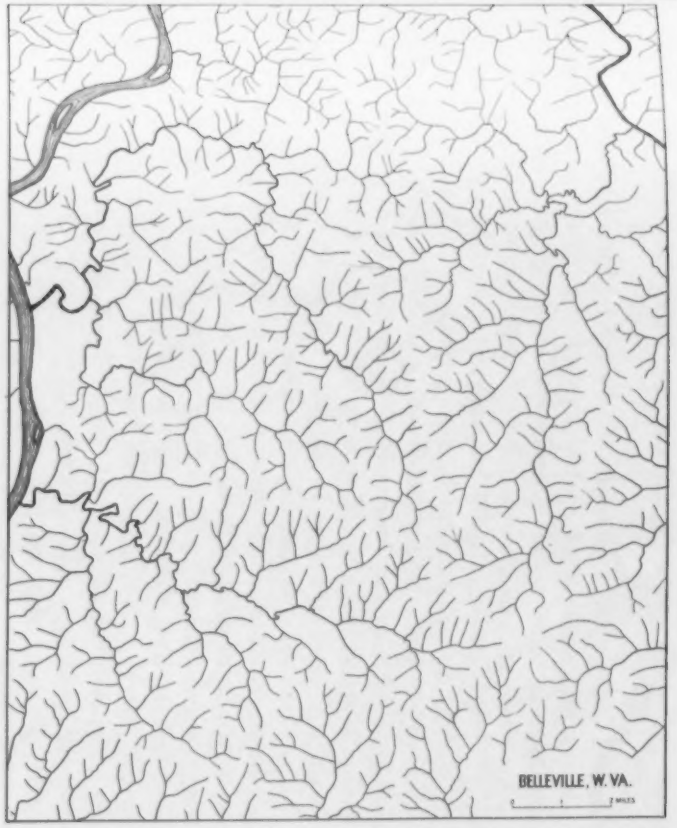

FIG. 4—Elaboration completed and extension at a maximum. The territory has been wholly occupied by streams

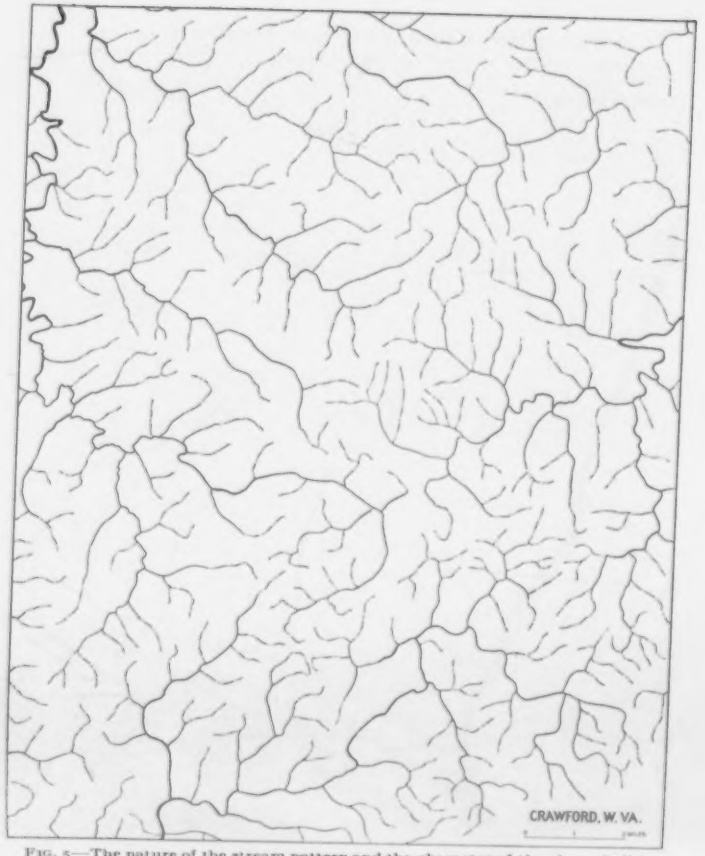

FIG. 5—The nature of the stream pattern and the character of the piracy indicate that maximum extension had existed at some time in the past.

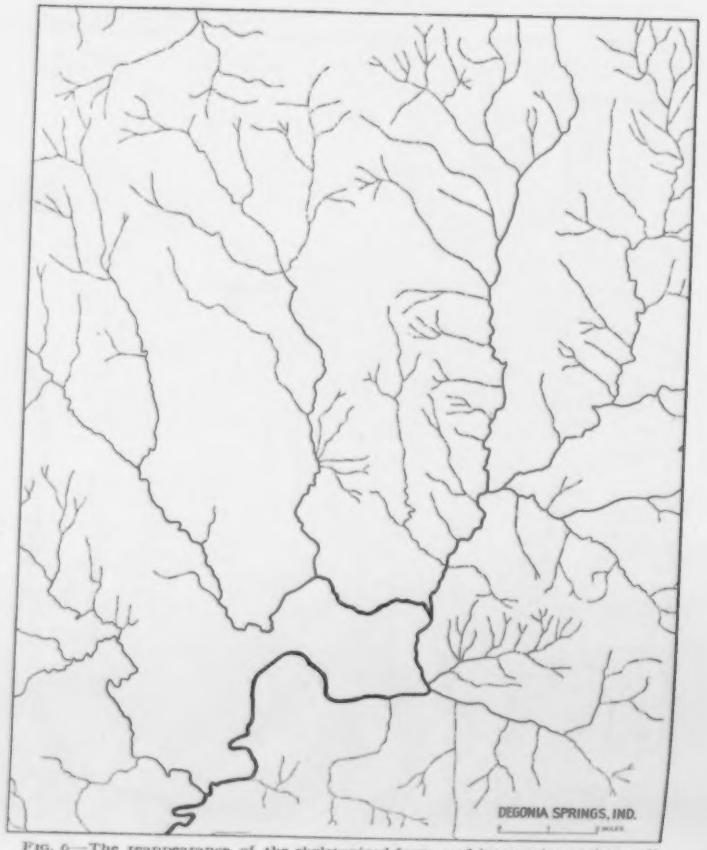

FIG. 6—The reappearance of the skeletonized form, and integration rather well begun.

extension as illustrated by Figure 1 is characterized by a notable lack of streams over a large percentage of surface, by the indefinite termination of many streams without combining into a main stream, and by the failure on the part of the existing streams to have started that active conquest of territory so typical of their future histories. These features are highly typical of the phase initiation but are not necessarily habitual. There is in truth a temptation to say that the drainage system is quite amorphous as yet. However that may be, a time of increasing activity follows the genetic period of hesitation and indecision. The streams begin the conquest of territory, some in a highly aggressive fashion, others in a more or less passive way.

Abbreviated streams and skeletonized systems characterize the stage of extension in a broad way, and these two characteristics must be eliminated before the stage is ended. The growing streams reach out into the territory bequeathed them and take possession of their inheritance by means of headward elongation which begins shortly after the efformation of the system. They sketch in, as it were, the lineaments of the future drainage pattern (Fig. 2). After the area has been thus blocked out the process of elaboration gradually eliminates the skeletal form by means of the addition and growth of minor streams (Fig. 3). A plexus of these accessory tributaries spreads outward from the mains until a veritable network of drainage covers the area first possessed by the elongated streams. With the progress of extension the abbreviated form commonly disappears first while the elimination of the skeletonized pattern, although beginning more slowly, endures throughout the entire stage.

The attainment of complete elaboration may be simply called maximum extension. It is the time of completed territorial conquest and minute invasion—the time of the fully developed drainage system (Fig. 4). The land surface, in other words, has been entirely occupied. Theoretically, the exact position and nature of maximum extension may appear to present unexpected difficulties in view of the almost infinite variation to be found among individual streams. The question may arise whether the elimination of the abbreviated streams on the one hand and the skeletonized system on the other may not lead to different extensional maxima, especially if opposing systems enter into active competition with each other, an activity tending to elongate certain streams at the expense of others. Should lengthening accomplished by piracy after elaboration has been completed fall within the scope of extension? It seems not. Figure 5 shows that a system may grow at the expense of a neighbor after maximum extension has been attained, since the pattern of the captured streams themselves indicates that the territory had been completely occupied when the piracy occurred.

From a practical standpoint, also, the essential termination

of the processes of elongation and elaboration may be more readily recognized and circumscribed if held to the simple concept inherent in the attempted description of extension. The scheme of classification

FIG. 7—Master streams and master tributaries late in the stage of integration.

to be desired is the one that is as simple and, at the same time, as adequate as possible. True maximum extension may be considered to refer to the completed invasion of the unoccupied surface within the jurisdiction of a particular drainage system after active elongation into rightfully inherited territory has added all possible area to the system. Hence, the intensity of intersystem strife may wax to a maximum either with, or after, the full development of the drainage systems, and extension may be at a maximum or may have definitely passed away when systems "come to an understanding about their drainage areas." Piracy between systems does not serve as a limiting criterion for extension. Treated, therefore, in the preferred fashion, the scheme is simple enough to conform to the standards which, it is

believed, an ideal scheme should follow. Little doubt can exist that such an ideal scheme acts as an axis of variation about which natural phenomena appear to group themselves.

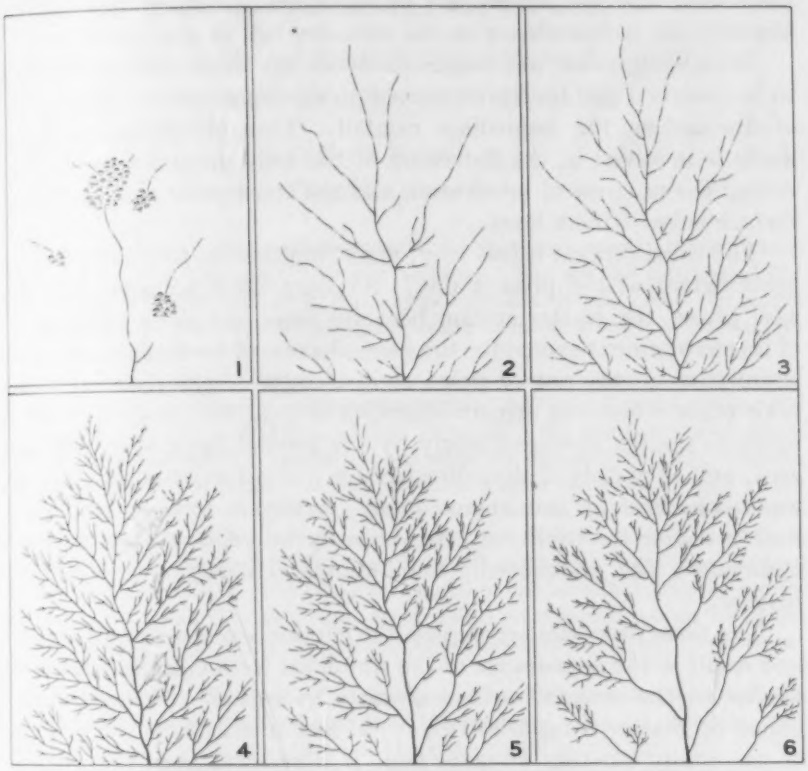

FIG. 8—An ideal diagrammatic summary of the development of a drainage system given for purposes of comparison only. The first four parts show extension, thus: 1, initiation; 2, elongation; 3, elaboration; and 4, maximum extension. Parts 5 and 6 represent steps during integration.

THE STAGE OF INTEGRATION

The processes responsible for integration may be designated as follows: (1) abstraction, the loss of identity suffered by a secondary stream at the hands of its primary; (2) absorption, the disappearance of a stream save immediately after rainfall; and (3) a sort of adjustment or aggression, the attempt made by the main stream to reach the sea by the shortest route consistent with regional slope. The reappearance of the skeletonized form out of the intricate plexus of streams some time after maximum extension definitely marks the existence of integration (Fig. 6). It constitutes the second and final stage in the developmental history of a drainage system.

Abstraction refers to the elimination of a secondary stream by its primary. As the stream swings from side to side it constantly

increases its own drainage area and thus abstracts territory from its tributaries. The lower portions of a tributary system may be dismembered in this way, all of the shorter branches may be completely destroyed, and the lower part of the chief tributary may lose its identity and independence on the meander belt of the master.

With integration well begun many of the minor tributaries seem to be absorbed and thereafter come into existence only for the purpose of discharging the immediate rainfall. Their disappearance quite likely is involved in the flattening of the local ground-water surface during the progress of integration and the consequent sinking of that surface below stream level.

The third process is less easy, if not impossible, to observe to any great extent at the present day. As integration advances into the final phase, the master stream becomes more and more independent of its environment except for the general slope of its drainage area and its relation to the sea or point of discharge. Aggression is said to take place when the stream attempts to gain the shortest (valley) route to the sea governed solely by the general slope of its drainage area, and then only if that direct route did not exist at initiation or was abandoned for any reason later. A stream having worked out such a course for itself may conveniently be called an integrational consequent and undoubtedly finds abundant illustration in geologic history.

The three processes accomplish the elimination of a host of streams and result in the appearance of the simplified form of integration very similar to the skeletal outline of early extension. Master streams joined by master tributaries (Fig. 7) at last emerge from the plethora of previously existing streams and, if necessary, seek the shortest practicable route to the sea.

In some respects integration appears to reverse the procedure of extension, as for instance the disappearance of minor tributaries, the continuation of which appears constantly to accentuate the original framework of the system. The stages in reality do resemble each other in that the sequence of changes (with one exception) sweeps headward along the trunk streams and thence to the chief branches, arriving finally at the outermost confines of the system—a migration quite naturally anticipated. Here, however, resemblance ceases.

There is no intention to infer that the scheme of development including extension and integration, because of its simplicity, possesses definiteness and perfection to such a degree that each is a distinct stage by itself. In fact, the two may always exist at the same time from a regional standpoint; or, further, extension may be occurring locally among the headwaters while integration is taking place farther down stream. Minor cases of actual overlap should be expected in any detailed study of a drainage system.

THE GEOGRAPHY OF SPEECH

PLANS FOR A LINGUISTIC ATLAS OF THE UNITED STATES AND CANADA

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IN every community there exists a certain degree of uniformity in speech, which is the result of common inheritance, of contact between the members of the community, and of a desire to make oneself understood with ease. The young learn from the old, and in a lesser degree the old from the young; and newcomers acquire the established dialect in whole or in part.

If the inhabitants of a village or a countryside have intimate contacts with a neighboring community, they may abandon some of their own dialectal peculiarities and adopt speech habits of their neighbors, especially if the community with which they entertain relations is of greater importance in the economic, political, religious, or cultural life of the region. Intermarriage, migration from the country to the city and back again, prolonged stays in other communities, the influence upon the pupils and students of teachers from other parts of the country and of teachers advocating "ideal standards" of speech ("better" and "purer" speech)—all these factors play their part in assimilating the speech of one community to the speech of other communities. If the diverse social groups are exposed to such influences in varying degrees, the original uniformity may be destroyed through the development of class dialects.

All such relations are forms of intercommunication, and, in so far as topography and arteries of communication determine the economic, political, religious, and cultural life of any given area, they also shape the speech of that area.

Barriers to communication, such as mountain ranges, forests, swamps, and the sea, serve to maintain and accentuate linguistic boundaries; they stop or retard the spreading of the dialects of dominating centers or social groups. That dialect features known to have been widely used in other parts of the South and in New England in earlier times have survived in the Appalachians and the Ozarks is doubtless to be attributed to lack of contact with the outside world. The pronunciation "hant" for "haunt," "sarmint" for "sermon," the word "poke" for "bag" or "sack," and the expressions "three mile," "acomin' and agoin'," "I reckon you be right," are instances of such survivals. For the same reason the inhabitants of Cape Cod and the islands along the New England shore preserve pronunciations, words, and expressions that in other parts of rural New England have given way to speech forms of urban centers.

Similarly, survival of Welsh and Gaelic in the mountainous areas of the British Isles, of Frisian on the islands in the North Sea, and of Basque in the Pyrenees is obviously to be attributed in large measure to natural barriers.

Ease of communication, on the other hand, breaks down dialectal peculiarities and clears the way for the spreading of "standard forms of speech" (*Kultursprachen*), which are in origin either dialects of the upper classes in culturally or politically influential centers, such as Paris in the case of France and London in the case of England, or the speech of cultural institutions, such as the stage in Germany. The influence of highways and navigable rivers is clearly discernible in the progress

of High German down the Rhine and in the march of Parisian French down the Rhone. In the United States the Ohio Valley, one of the channels through which the population poured into the West, is surprisingly uniform in speech.

Topography and arteries of communication have no direct bearing on the development of dialects; their influence is of a more or less indirect nature. They are effective in shaping speech only in so far as they determine intercommunication, movements of population, and the organization of political and economic provinces. In the United States the westward movement of the population followed certain naturally defined channels, so that the westward sweep is more or less clearly reflected in the present distribution of speech peculiarities. But other factors have been equally potent in shaping the spoken language. For instance, the sectionalism that led to the Civil War and to the prolonged hostile attitude of the South and the North toward each other has undoubtedly resulted in preserving and accentuating speech differences.

In Europe one can point to many areas in which political and ecclesiastical boundaries have had a decisive effect on the linguistic development. The folk speech of Yorkshire is much more closely akin to that of Scotland than to the folk speech of the London area; and yet, because of their political affiliation, cultured Yorkshiremen accept cultivated London English as their standard, while in Scotland the educated continue to speak a language that has its roots in the dialect of the upper classes of the region of Edinburgh. In northern Germany the native Low German has, since the Reformation, given way to High German, i. e. a literary dialect of the central region of the present Reich, while Dutch, a Low German dialect, has survived as the literary language of the Netherlands.

Some scholars of an older generation assumed that climate has a direct influence on speech. The nasal twang of New Englanders was attributed to a reluctance to open the mouth in inclement weather, which made them talk through the nose. But the nasal twang is just as common in the mild South. The German *ach* sound and similar sounds in Dutch and Scottish are popularly associated with the severe climate of northern Europe, but Spanish and Arabic have friction sounds of the same type. The melodious intonation of some Southerners and the strained voice of others do not grow out of soil and climate but reflect divergent types of social life of the past and the present—which, to be sure, are in part the outgrowth of soil and climate—or are handed down from European forbears whose condition of life we do not know. Whatever the conditions for and the causes of such striking features of speech may be—and linguists are rather at sea in this matter—they must be sought in the racial, social, and cultural sphere and not in topography and climate.

European Linguistic Atlases

Before a scientific study of the influence of the "lay of the land" and of social, political, and cultural organization on linguistic development can be undertaken, the facts of the spoken language of all classes must be gathered systematically and presented in well organized form. Students of language have realized this for some time. Within the last half century the folk speech of Germany, France, Italy, Switzerland, and other European countries has been studied systematically, and the materials have been published or are now being published in impressive linguistic atlases each of which contains from several hundred to several thousand maps showing the geographic distribution of dialectal features.[1] Moreover, historical inter-

[1] Jules L. Gilliéron and E. Edmont: Atlas linguistique de la France. 8 vols., Paris, 1902–1912; Supplement, 1921. More than 1400 complete maps and 500 sectional maps.

Georg Wenker and Ferdinand Wrede: Deutscher Sprachatlas, Marburg, 1926–1930. Four instalments to date.

Karl Jaberg and Jakob Jud: Sprach- und Sachatlas von Italien und der Südschweiz. Zofingen, 1928—. 8 vols., three of which have appeared so far.

pretation of the material has made considerable progress in these countries, and general principles of linguistic change have been formulated which amplify earlier conceptions and refute others that rest on a less secure foundation.[2]

The English-speaking countries are lagging far behind the countries of Continental Europe in this respect. The work of Ellis and of Wright in England is merely a first step,[3] and the United States and Canada have been barely touched.

Proposed Linguistic Atlas of the United States and Canada

The importance of a systematic survey of the spoken language of the United States and Canada is widely recognized. In 1929 a conference was held of about fifty interested American and Canadian scholars. Upon the recommendation of this conference a committee was appointed by the American Council of Learned Societies "to prepare plans and to study ways and means for the preparation of a Linguistic Atlas of the United States and Canada." As an experimental project preliminary to this larger undertaking, the dialects of New England will be investigated and a dialect atlas of New England compiled. Field studies in New England are to begin in the summer of 1931.[4]

A linguistic atlas of the United States and Canada is urgently needed as a basis for all intelligent work on our dialects, for studies in the development of the various types of cultivated speech in the several sections of the two countries, and for an understanding of the racial, social, political, and cultural forces that have played a part in the shaping of our language. Moreover, the linguistic atlas and the researches based upon it will furnish the historian of population and of social institutions a large body of definite and valuable information.

How can such an atlas be constructed? It is the purpose of a linguistic atlas to provide a systematic collection of the facts of linguistic usage. But obviously such a collection cannot be exhaustive: only the essential features, or what seem to be the essential features, of the dialects can be recorded; and the investigation must be confined to a small number of representatives of the various social groups in a limited number of communities.

The scientific value of speech maps depends largely on the careful selection of representative communities, on the choice of persons representing the various social groups in each one of these communities, and on the selection of essential features of speech that are known to vary from section to section and by social groups.

The choice of representative communities must be based on available linguistic and historical information. Both the present composition and the history of the population must be taken into account. For the guidance of those who will use the atlas a brief account of the history and the present state of the community must be

[2] E. C. Roedder: Linguistic Geography, *The Germanic Review*, Vol. 1, 1926, pp. 281–308; Albert Dauzat: La géographie linguistique, Paris, 1922; Ernst Gamillscheg: Die Sprachgeographie, Bielefeld, 1928; Karl Jaberg and Jakob Jud: Der Sprachatlas als Forschungsinstrument, Halle, 1928; Kurt Wagner: Deutsche Sprachlandschaften, Marburg, 1927; Johannes Brøndum-Nielsen: Dialekter og Dialektforskning, Copenhagen, 1927; S. Pop: Buts et méthodes des enquêtes dialectales, Paris, 1927; Georges Millardet: Linguistique et dialectologie romanes, Montpellier, 1923; Ferdinand Wrede: Ethnographie und Dialektwissenschaft, *Historische Zeitschrift*, Vol. 88, 1902, pp. 22–43; Otto Bremer: Politische Geschichte und Sprachgeschichte, *Historische Vierteljahrschrift*, Vol. 5, 1902, pp. 315–346; Louis Gauchat: Gibt es Mundartgrenzen?, *Archiv für das Studium der neueren Sprachen*, Vol. 111, 1904, pp. 365–403; A. Brettschneider, Sprachkarte und Sprachgeschichte, *Indogermanische Forschungen*, Vol. 48, 1930, pp. 181–221; Eugen Oberhummer, Geographie und Sprachenkunde, *Petermanns Mitt. Ergänzungsheft No. 209*, 1930, pp. 253–264.

[3] Alexander J. Ellis: On Early English Pronunciation, Part V: Existing Dialects, London, 1889. Joseph Wright: The English Dialect Dictionary, 6 vols., London, 1898–1905.

[4] Hans Kurath: Report of the Conference on a Linguistic Atlas of the United States and Canada, *Linguistic Soc. of America Bull. No. 4*, 1929.

A Linguistic Atlas of the United States and Canada. (Leaflet published by the American Council of Learned Societies.) Washington, 1930.

provided. However, the study of population has until recently received so little attention from historians and geographers[5] that the student of dialect will often of necessity be a pioneer. The dialectal features to be recorded by him will themselves provide significant clues to the history of the population.

Wherever linguistic and historical information is lacking or insufficient, the dialect workers will have to rely on local informants and do the best they can to separate the wheat from the chaff in the information offered. Doctors, lawyers, clergymen, and local officials who have extensive and varied contacts often know the population of village or town exceedingly well and can be of great service in orienting the dialect student. Over and above this, the intelligence and the sagacity of the fieldworkers will count for much. Lest the bulk of the material should become unwieldy for cartographic presentation, the recording must be confined to a small number of wisely chosen individuals in each community. Careful selection of dialectal features that are to be recorded is of equal importance—variations in pronunciation, intonation, inflections, vocabulary, and idiom. It is obviously impossible to include them all.

All records must be made on the spot by specially trained fieldworkers. The immediate products of the fieldwork will be brief monographs on the speech of the representatives chosen. These will be assembled in a central bureau, where the construction of the maps will be undertaken.

For each dialectal feature a separate map will be made, on which each community studied will be represented by one or several entries, according to whether local usage is uniform or divided. Numbers prefixed to the entries will make it possible to identify the individuals in each community. By referring to the brief personal histories taken down by the fieldworkers the users of the atlas will be in a position to tell in what classes of society any given form is current. Thus the maps will convey information concerning both the geographic and the social distribution of dialectal features.

An example may serve to explain the nature of speech maps. If a thousand communities in the United States and Canada were to be investigated, the "bird" map would show how the "ir" is pronounced in each one of the communities and also whether usage is locally divided or not. One could see at a glance the areas in which an "r" is sounded and those in which it is not sounded. On closer inspection one could determine in what areas usage is divided and how it is divided. But the map would do much more: it would, by implication, show how the stressed vowel in hundreds of words of the type of "bird," "hurt," "fern," "learn," etc. is sounded.

From a comparison of the maps of various dialectal features it will appear that the distribution of some of them partially coincides, though the coincidence is rarely if ever complete; and systematic comparison will ultimately make it possible to delimit dialect areas. It will doubtless be found that the areas shade off into each other; but in some places boundaries of phonetic, inflectional, syntactical, and lexical characteristics will coalesce more than in others. Such bundles of boundary lines may be considered dialect boundaries.

Not until the maps have been prepared and made the subject of a thorough study shall we be able to undertake the historical and social interpretation of the origin of central dialect areas and border zones.

The construction of simplified maps of dialect centers and borderlands will be the last step in the cartographic presentation of the speech material. Such maps will be based on the geographic distribution of the most characteristic dialectal features.

[5] Such studies as Guy-Harold Smith's "The Populating of Wisconsin" (*Geogr. Rev.*, Vol. 18, 1928, pp. 402–421) and such surveys as that of New England undertaken by the American Geographical Society and described in the *Geographical Review* (Vol. 19, 1929, pp. 479–494) will aid greatly in facilitating the work of the linguist.

AMERICAN GEOGRAPHICAL SOCIETY

The March and April Meetings. The regular monthly meeting of the American Geographical Society was held on March 24, 1931, at the Engineering Societies' Building, 29 West 39th Street, President Finley in the chair. Mr. Upton Close spoke on "Folk Festivals of Pacific Asia." His lecture was illustrated with motion pictures taken for the Imperial Museum of Chosen and shown for the first time in America by special courtesy of the Governor-General of Korea.

The regular monthly meeting of the Society was held on April 21, 1931, at the Engineering Societies' Building, 29 West 39th Street, President Finley presiding. The meeting was devoted to the Pacaraima-Venezuela Expedition in process of organization for exploration in southern Venezuela. Dr. Frank M. Chapman of the American Museum of Natural History spoke on "Geographical Problems of Bird Migration and Distribution." The specific interests of the three institutions coöperating in the work of the expedition were briefly presented by Mr. H. E. Anthony, Curator of Mammals, American Museum of Natural History; Dr. H. A. Gleason, Curator, New York Botanical Garden; and Mr. R. R. Platt, Head, Department of Hispanic American Research, American Geographical Society.

At the March and April meetings of the Society, President Finley presiding, there were presented with the approval of the Council the names of twelve candidates who were duly elected as Fellows of the Society.

Award of the Charles P. Daly Medal for 1931 to Gunnar Isachsen. Announcement is made of the award of the Charles P. Daly Medal for 1931 to Major Gunnar Isachsen, Director of the Maritime Museum, Oslo, for his contributions to our knowledge of the polar regions. Major Isachsen was topographer on the Second Norwegian Arctic Expedition in the *Fram* under Sverdrup (1898–1902), when important discoveries were made in the Canadian Arctic Archipelago. During 1906–1910 he spent four summers in Spitsbergen, the two former in charge of an expedition under the auspices of the Prince of Monaco; the two latter as leader of the Norwegian Expedition to Spitsbergen. On all expeditions excellent cartographical work was accomplished. Major Isachsen visited the Antarctic in 1926–1927 for study of the Norwegian whaling industry in these waters, an account of which he presented in the July, 1929, number of the *Geographical Review*. This last season, 1930–1931, he commanded the *Norvegia* on her circumnavigation of the Antarctic, Consul Lars Christensen's project for study of the number and distribution of whales.

Gift of Arctic Photographs and Maps. Through the generosity of a Fellow of the Society, Miss Louise A. Boyd of San Francisco, there have been donated to the photographic collections of the Society two sets of films and prints of exceptional interest: (1) Arctic stills and motion pictures and (2) photographs of Lapland—people, costumes, buildings, and typical activities. Miss Boyd conducted an expedition to Franz Josef Land in 1926 and participated in the official search for Captain Roald Amundsen in 1928. The tracks of the vessels concerned have been plotted in detail upon maps also donated to the Society, in addition to maps that show the course of the M. S. *Hobby*, commanded by Miss Boyd in the cruises of 1926 and 1928, and photographs of documents that describe in detail the cruises of 1928. Miss Boyd's generous gift, of special value in the study of types of ice in the Arctic, comes at a time when the photographic collections of the Society are in process of systematic analysis and classification.

GEOGRAPHICAL RECORD

NORTH AMERICA

Clipperton Island. In February last it was announced that sovereignty over Clipperton Island, disputed by Mexico and France, who in 1909 had referred the matter to the king of Italy as arbiter, had been awarded to France.

The dispute belonged to another generation, and it it safe to say that very few people in Mexico—and perhaps fewer still in France—knew anything of it. Two interesting addresses on the subject were delivered at the session of the Mexican Geographical Society on February 17, and the papers carried accounts of the antecedents of the dispute. An official statement of the case "Isla de la Passión llamada de Clipperton" was published by the Secretaría de Relaciones Exteriores in 1909.

The first time Clipperton Island, or Passion Island as it is also known, came to the notice of the general public was on August 14, 1897, when the *New York Herald* published the rumor of a proposal to hoist the British flag over Clipperton Island, "located in the Pacific south of Acapulco." The Mexico City paper *El Tiempo* on the 24th of the same month carried an extensive account of this matter with antecedents of Mexico's claim to the island. *El Tiempo* at the same time cited the instance where another island belonging to Mexico—namely Clarion Island in the Revillagigedo group—had been occupied by the British and the attempted occupation of Guadalupe and Arenas Islands by the United States.

After this publicity the Mexican Minister of Foreign Relations ordered an investigation. On January 1, 1898, the gunboat *Demócrata* returned from the investigation and reported on the "island lagoon," as it was called. After great difficulty, owing to the heavy seas, a landing was effected, and three men were found on the island, two Germans and a Britisher, who, when the landing party came ashore, hoisted the American flag. These men were employees of the Oceanic Phosphate Company, of San Francisco, Cal., and they took their departure without protest when the Mexican flag was raised.

The report describes Clipperton as a bare and desolate island lying in latitude 10° 17′ N. and longitude approximately 109° 10′ W. The length is three and a half miles, the breadth two and a half. In its center is a lagoon of fresh but undrinkable water which varies in depth from two to twenty feet; and the island proper consists of little more than a ring surrounding this lagoon, the width of the land narrowing down to 300 feet or less. The main part of the island is elevated only some ten feet above the level of the sea and is almost awash during heavy storms. A steep rock, likewise arid, which from afar assumes the appearance of a sailing vessel, rises some 36 feet in height from the southern portion. An islet, shown in old charts as being in the center of the lagoon, no longer exists. It was stated by early navigators that the lagoon communicated with the sea in two places; but, like the islet, the passes to the sea no longer exist. Rains occur at frequent intervals, and it is possible to store rain water for drinking purposes. It is difficult for a vessel of any size to find anchorage, and only small vessels can come close enough inshore to find holding ground. Landing is dangerous except in a calm sea.

The interesting question of the origin of the island was raised by Admiral Wharton in 1898 (Note on Clipperton Atoll (Northern Pacific), *Quart. Journ. Geol. Soc. of London*, Vol. 54, 1898, pp. 228–229). Professor W. M. Davis uses it as a delicate test of Darwin's coral reef theory (The Coral Reef Problem, *Amer. Geogr. Soc. Special Publ. No. 9*, New York, 1928, p. 540).

An abundance of fish and a great number of sharks in the immediate vicinity of the island are reported. Birds are present in countless numbers, and the island's only commercial value lies in the great quantity of guano found there. Various companies exploiting guano have from time to time entered into arrangements with the Mexican Government for working the product, and Mexico for many years past has kept a small garrison on the island.

France's claim to the island dates from 1858 when, in a letter of December 10 of that year, Lieutenant Le Coat de Kevérguen informed the French agent in the Sandwich Islands that he had taken possession of the island in the name of France, having regarded it as *territorium nullius*. The Mexican claim dates from Spanish colonial days when Spanish navigators scoured the Pacific again and again and took possession of Passion Island, which the Mexicans claim is one and the same as Clipperton.

In the hands of a first-class power, on the direct steamer route between Japan, the Hawaiian Islands, and the Panama Canal, with a still-water lagoon, and within an easy distance from the canal, Clipperton Island takes on a strategic importance.

OTTO HOLSTEIN

Geography and Taxation in the United States. In a recent study entitled "The Geographical Problem in Wisconsin Taxation" (*Wisconsin Tax Commission Bull. No. 39*, Madison, 1930) J. R. Blough makes it clear that "northern Wisconsin counties and certain central counties have decidedly less ability to support governmental functions than do southern and eastern counties." This is confirmed by a striking series of diagrammatic maps showing the distribution of tax bases and taxes levied. Regional differences in industry, density of population, and wealth give rise in Wisconsin, as everywhere, to geographical inequalities and conflict of interests in the matter of taxes.

Where there is much tax delinquency on farm and forest lands it is to be presumed that the last stages have been reached in a long process of rural decline. This is true of parts of northern Wisconsin and Michigan. The situation in the latter state in its geographical aspects has been investigated by K. C. McMurry and Mary Greenshields (Some Geographic Relationships of Tax Delinquency in Michigan, *Papers Michigan Acad. of Sci., Arts, and Letters*, Vol. 14, 1931, pp. 377–387). Delinquent lands are mapped decade by decade from 1880 on and are analyzed in terms of soil and vegetation cover. In the Lower Peninsula it was found that only the lands with poorer soils and inferior types of cover have reverted to the state for unpaid taxes.

Declining rural areas in New York State have been made the object of intensive study by members of the staff of the New York State College of Agriculture, Cornell University (L. M. Vaughan: Abandoned Farm Areas in New York, *Cornell Univ. Agric. Exper. Sta. Bull. 490*, Ithaca, 1929). The fiscal problems of these areas are discussed in a scholarly monograph prepared by R. T. Compton for the Bureau of Research of the New York State Tax Commission (Fiscal Problems of Rural Decline: A Study of the Methods of Financing the Costs of Government in the Economically Decadent Rural Areas of New York State, *Special Report of the New York State Tax Commission No. 2*, Albany, 1929).

Compton shows that there are widespread farming districts in New York where farmers' incomes "are insufficient to provide 'living wages.'" In these communities tax problems assume an importance out of all proportion to their importance in more prosperous regions. "In the school year, 1922–1923 school taxes varied between districts from 0 to $4.80 per $100 of estimated full valuation." Tax burdens in some areas are so great as to be confiscatory. This is the case in many of the abandoned farm areas.

Two types of remedy are suggested. One is the gradual elimination of farming population altogether from the decadent rural areas. The state could purchase low-priced lands and reforest them, or it could subsidize private reforestation. In any case there should be a consistent program based in its detailed applications upon the study of large-scale maps showing land classification, farms, schools, roads, resorts, water power, delinquent lands, etc. Such maps do not exist.

The second type of remedial measure is the lightening of tax burdens through administrative reorganization. Compton believes that town (i. e. township) governments should be done away with altogether and their functions assumed by the counties: that school districts should be abolished in so far as they represent areas marked out for tax collecting purposes: and that certain counties should be merged together in order that the resulting county boundaries may correspond more closely to existing economic regions.

The need that has arisen in New York for administrative reorganization may be attributed to the operation of an almost universal law of history, a law that might be stated thus: Administrative geography tends to change more slowly than economic geography; nearly always and nearly everywhere it fails to keep pace with an ever-changing economic area.

SOUTH AMERICA

Abnormal Occurrence on the Littoral of the Santa Elena Peninsula, Ecuador. Mr. George Sheppard of the State Geological Department of Ecuador, who has contributed valuable meteorological data from Santa Elena for a number of years, sends the following note to the American Geographical Society.

During the month of February of this year an unusual phenomenon has been observed in connection with the coastal waters of the Pacific from the headland of Santa Elena to the north of Esmeraldas, Ecuador. The normal blue and clear waters of the ocean along the littoral zone have been replaced by turbid, yellowish-brown lenses of water that emit a most disagreeable and fetid odor suggesting stagnant swamp conditions. These discolored patches, which occur not only along the shore line but have been reported in the steamship lanes from Panama southwards, indicate that they have been possibly induced by the equatorial current from the north, El Niño, which is in evidence at this time of the year (cf. R. C. Murphy: Oceanic and Climatic Phenomena Along the West Coast of South America During 1925, *Geogr. Rev.*, Vol. 16, 1926, pp. 26–54).

An examination of the discolored water under the microscope has revealed the fact that it is full of plankton material, the greater part consisting of spores of some marine alga, and there is no suggestion of mud or other detritus of a sedimentary nature. The idea has been put forward that the normal plankton of the Humboldt Current has succumbed, owing to the higher temperature of the equatorial current; on the other hand, it is possible that the sudden increase in temperature of these waters, caused by the influx of the warm waters from the north, may have been responsible for an abnormal fructification of the larger marine algae with a consequent dissemination of spores in sufficient numbers to discolor the water. From whatever cause, however, the phenomenon is unusual and has never been noticed by the writer before during his eight years' residence in this part of South America.

EUROPE

The Sphere of Influence of Split. Discussing the sphere of influence of Split (The Gravitation of Population towards Split, *Hrvatski Geogr. Glasnik*, Vol. 2, Zagreb, 1930: in Croatian with French résumé) Ivo Rubić depicts it as a "city awake," to use the definition of Professor Jefferson elsewhere in this number of the *Review*.

The ordinary resident (census) population of Split is swollen by a daily "anthropic

tide," which Dr. Rubić analyzes into three major components. From the near-by environs come 1000 to 2500 persons a day; from the more distant environs, from which travel to the city and return can still be accomplished in the day, come 500 to 1000 persons, about half of them by water from the mainland shores and islands. Farther away the sphere of attraction extends to such plains of the high karst as Livno and Glamoč (compare the map of geographical regions in B. Ž. Milojević's "The Kingdom of the Serbs, Croats, and Slovenes," *Geogr. Rev.*, Vol. 15, 1925, pp. 70–83). These plains constitute a link between the seaboard and the Pannonic plains, but because of the complementary character of their products their relations are rather with the littoral than the interior; they are rich in grain, fruit, wood, and their cattle fairs are especially interesting and important. A fourth source of attraction is to be found in the tourist trade, which draws visitors from more remote parts of Jugoslavia and from foreign countries and, including in this class visitors who stay at least two days, accounts for an average of 140 a day in the season, May to November.

Split is also attracting an increasingly large resident population. From a total of about 25,000 at the 1920 census the population has grown to over 40,500 in 1929. In part this great gain is attributable to the passing of Trieste, Fiume, and Zara to Italy; in part to active measures to promote Split as the country's major port—the junction by rail with Zagreb, for instance, was accomplished in 1925. This growing importance of Split should be encouraged by the recent reforms whereby the town has been created the center of the large administrative division (*banovina*) of the Littoral, approximately coincident with its economic sphere.

Attention may also be called to the descriptions of Split and its environs by Milojević and Rubić in the guidebook of the Third Congress of Slav Geographers and Ethnographers held in Jugoslavia in 1930 (Belgrade, 1930, Part II, pp. 108–123).

La Mancha and the Cantabrian Mountains and the North Spanish Riviera. What makes the charm of the arid landscape of the Spanish interior? Otto Jessen refers to it in the preface of his paper "La Mancha" (*Mitt. Geogr. Gesell. in Hamburg*, Vol. 41, 1930, pp. 123–227), though he does not analyze it in the pages that follow. The writer has a similar feeling for the arid Argentine and parts of our dry southwest. They are monotonous, often dull of color, though glaring under the full sun. For weeks and months they offend eyes accustomed to well-rained-on landscapes, but certainly with time one does become very much attached to such scenes.

La Mancha, a sagging peneplain between the mountains of Toledo, the Sierra Morena, and the mountains of Cuenca, lies 600 to 700 meters above the sea and is now chiefly grain and wine country. The annual rainfall is less than twenty inches: June, July, and August have almost none, and clear skies assure a tremendous evaporation. Typical landscapes have no tree in sight. The cities are bare of every kind of vegetation without and within. There are vast levels like the Pampa or the sea but also abundant hollows and gentle elevations affording broad views in which observers find the Manchego charm. Summer is frightfully hot and winter painfully chilly. There are but two or three days with snow, but the cold is painful because inescapable. The houses of the patio type, which serve admirably in Andalusia where the winter is mild, are entirely unfit for La Mancha. They are not heated, in fact are regarded as unheatable. In Villacañas and Chinchilla are subterranean houses that are snug enough in winter, thanks to lack of openings on the outer air. They are clean, too, and wholesome, though mostly inhabited by poor folk. The well-to-do Manchegan puts on more clothes, wraps up his throat, drinks coffee, smokes cigarettes, and waits miserably for spring.

La Mancha has no great city; no chief city even, no one city that claims the whole region as its sphere of economic or social influence, though the persistence of the regional name must mean that the Manchegos have a distinct sense of regional

unity even into the southern corners, the Campo de Calatrava and the Campovde Montiel. Albacete is the only actively prosperous city, with 23,000 inhabitants "and great hotels."

Jessen found the people hospitable to strangers but not to new ways. Farming is old-fashioned and inefficient. The Manchegans cannot be said to have made the best of their environment. They have survived where an enterprising race might have thriven, though the reader cannot help wondering if their apathy may not result from bad government. Don Quixote figures often in Jessen's pages, and his most excellent photographs give a vivid sense of the natural and human environment.

Erwin Scheu also speaks of the strange charm of the arid Spanish interior while contrasting it with the north coast (Das Kantabrische Gebirge und die nordspanische Riviera, *Mitt. Gesell. für Erdkunde zu Leipzig*, Vol. 49, 1925–1929, pp. 7–136): the steep-sloping, oceanic north, well watered, with warm but not hot summers, cool, very cloudy and rainy winters, over against the hotter and colder and always drier south: a north dressed in verdure, where maize and apples and cattle are the crops, cider the drink, over against a south where trees are lacking unless they be olives, monotony of tint prevails, where wheat is the bread crop, and wine is grown and drunk. Out of the multiplicity of details that fill Dr. Scheu's pages another geographic feature of the landscape that comes out clearly is a series of five or six striking coastal terraces, up to some 300 meters height, for 250 miles along the coast of northern Spain, rather usually cutting across steep-dipping strata and utilized toward the Pyrenees by Basque farmsteads and in Asturias by handsome estates of Spaniards returned from Cuba with money to display.

In all his attention to landscape detail Dr. Scheu, however, makes no attempt to show that the coal and iron of the north are related to the landscape (as they may be) nor why, except for easier smelting, they are exported in the west but exploited industrially in the east—Guipuzcoa. Possibly the Asturians do not enjoy the ancestral privileges (*fueros*) which the Basques defend so jealously and which relieve them of taxes on industry such as the Castilians enjoy! In Castile, the author admits, there would be no profit in such industries as thrive in Guipuzcoa. Another blessing of bad government for the Castilian: he is less enterprising than the Basque because he is too much taxed if he works.

MARK JEFFERSON

A Seismological Map of Northern Europe. This map by K. E. Sahlström (*Sveriges Geol. Undersökning*, Ser. C, No. 364 (Årsbok, 1930, No. 1), Stockholm, 1930) shows the number of earthquakes in Finland, Sweden, Norway, and Denmark during the period 1600–1925. The scale of the map is 1 : 5,000,000. The Finnish part is after Henrik Renqvist, whose method of construction has been followed (Über kartographische Darstellung der Seismizität, *Zeitschr. für Geophysik*, Vol. 4, 1928, pp. 348–352. See also E. Tams: Die Erdbeben Finnlands [after H. Renqvist], *ibid.*, Vol. 7, 1931, pp. 145–149). By Renqvist's method the area affected by each quake is entered on a separate map. A map of the whole territory studied, on the same scale and covered with an even stipple, is laid in turn over the individual maps, and it is noted how many times each dot falls in an affected region: the total numbers thus recorded are entered on a new dot map and serve as basis for lines of equal frequency of quakes.

The total number of earthquakes covered by Sahlström's survey is 523 for Sweden and 718 for Norway. The regions of highest seismicity are the Bothnian region, the Oslo-Vänern region, westernmost Norway (Vestlandet), and the Norwegian coast south of Bodö (Nordlandet). The regions of the lowest seismic activity are the northern and interior parts of Scandinavia, southern Finland, southeastern Sweden, and Denmark. The earthquakes seem to be connected with the rise of the land that still goes on as an aftermath of the last glaciation.

ERNST ANTEVS

AFRICA

Some Recent Studies of African Rainfall. The monsoonal nature of the climate of the Guinea coast and its hinterland is well known: the effect of the monsoon, indeed, is felt far inland within the southern Sahara. In Aïr and neighboring regions recent meteorological investigations have shown that "the year is divided into a long dry season in the winter half year, with north-easterly winds (the 'Harmattan' of the Guinea coast), very clear skies and a practically complete absence of rain, and a summer season with south-westerly winds, more cloudy skies and more or less rain. . . . The south-westerly current of the summer monsoon is shallow, probably only about 1,000 meters in thickness, and is overlain by easterly winds. At times during the occurrence of rainstorms these easterly winds break through and reach the surface" (C. E. P. Brooks and S. T. A. Mirrlees: The Meteorological Results of Journeys in the Southern Sahara, 1922 and 1927, Made by Francis Rennell Rodd, *British Meteorol. Office Geophys. Memoirs No. 48*, 1929, pp. 6 and 7). The interaction of these two sometimes gives rise to extremely violent and destructive thunderstorms, known in west Africa as "tornadoes," although not the same as the "twisters" of the western plains of the United States.

The former German colony of Togoland lies in the midst of the West African monsoon belt. Its rainfall has recently been studied by Raoul Pignol (Die Niederschlagsverhältnisse des alten deutschen Schutzgebietes Togo, *Aus dem Archiv der Deutschen Seewarte*, Vol. 49, No. 6, Hamburg, 1931). On their great climatic map of the world, published by Justus Perthes in 1928, W. Köppen and R. Geiger place the whole of Togoland in a zone designated as having two dry and two rainy seasons each year. Pignol's studies, however, indicate that only southern Togoland has the characteristic equatorial double dry and wet seasons. In the interior there is but one dry period, lasting from November to February or March in the center and from October or November to April or May in the north. The coastal strip of Togoland receives less annual rainfall than the interior (600–1000 mm., as compared with 1000 mm. to over 1500 mm. on the uplands). The summer onshore monsoon produces an upwelling of cool water along the coast. As the low-lying coast is in general warmer than the neighboring sea, "the winds coming from the sea cannot produce heavy precipitation," as they do farther inland where "forced to ascend by mountain heights."

The northern fringes of the Sahara have a wholly different climatic régime. Winter is here the rainy season. In Italian Libya rains are confined almost exclusively to the period from October to March; but even during these months there are relatively few rainy days, and what rain there is is undependable. Throughout Libya rain almost never falls except with northerly to westerly winds. Precipitation decreases as one goes from narrow belts along the coast, characterized as having "sufficient rain" (300–400 mm.; compare New York with about 1100 mm.), into the desertic interior, with less than 50 mm. In the desert "the rains are absolutely sporadic and ordinarily of minimum quantity." (Amilcare Fàntoli: Le grandi linee della distribuzione pluviometrica in Libia e nelle sue regioni adiacenti, *Rivista delle Colonie Italiane*, Vol. 4, 1930, pp. 1103–1111.)

The maximum rainfall for a single day ever reported in Egypt was 279.9 millimeters at Alexandria on December 9, 1888. This figure is comparable with the maximum for New York (234 mm.). It is possible, however, that a waterspout in the neighborhood may have affected the record. At Mersa Matruh on the Mediterranean about 140 miles west of Alexandria on December 28, 1930, there was a fall of 99 millimeters, which constitutes the record for Egypt if we rule out the figure for Alexandria. Heavy rains in desert regions do vastly more damage than rains of the same intensity elsewhere. The Egyptian rains of December, 1930, wrecked many of the mud houses in the Siwa oasis and at other points. "A single storm

(45 mm.) in 1919 . . . flooded the electric railway between Cairo and its suburb Heliopolis, and caused the suspension of the service for a fortnight." Forty thousand tons of water and 20,000 tons of sand had to be removed from a single cutting (L. J. Sutton: Exceptional Rain in the Libyan Desert, *Meteorol. Mag.*, Vol. 66, 1931, pp. 29–31).

Fisheries of the Great African Lakes. The great lakes of central Africa abound in fish. Around the shores and on the islands of Lake Victoria—which is nearly as large as the state of Maine—dwells a fishing population estimated at 135,000. In the course of ages these people have devised highly developed techniques. The predominant fish in Lake Victoria is the ngege (*Tilapia esculenta*), or carp, which is caught in floating seines made of papyrus. These seines, sometimes as much as 250 yards in length, are "drawn in toward the shore, and a line of non-return baskets is placed in the water so that the fish are driven into them." The baskets, constructed of wickerwork on the principle of a flytrap, are beautiful pieces of handicraftsmanship. Spears, hooks and lines, nets, poisons, etc., are also employed in the fisheries, and distinctively European methods are now being introduced. To facilitate an expansion of the market for ngege, experiments have been made with a view to perfecting a form of "kippering," which should permit the shipment of palatable fish to considerable distances from the lake.

Lake Albert—larger than Delaware—lies in the African Rift Valley and is much the shallowest of the lakes in this great depression. The maximum depth is "47 metres as opposed to 786 metres in Lake Nyasa and 1,435 metres in Lake Tanganyika. Lake Albert, unlike these other lakes, has large affluents which pour into it enormous quantities of silt during the rainy seasons." Along the eastern coast a series of sand spits, in the form of cuspate forelands, give shelter to bays on the shores of which cluster the fishing villages. Sleeping sickness, however, has scourged this region.

Lake Kioga for the most part is not over 12 feet deep. Its waters merge into papyrus swamps, and vast masses of sudd, or vegetal matter, float about on its surface. As this cuts off access to open water, most of the shore is uninhabited. In some places small temporary fishing villages are actually built on the floating sudd and occupied by men during a few months of each year. The women and cattle are left behind on the mainland.

During the last few years detailed surveys for the Conference of East African Governors have been made of the fisheries of Lakes Victoria, Albert, and Kioga (see Michael Graham: The Victoria Nyanza and its Fisheries . . . 1927–1928; and E. B. Worthington: A Report on the Fishing Survey of Lakes Albert and Kioga, March to July, 1928, both published by the Crown Agents for the Colonies, London, 1929). Similar explorations are being conducted this year on Lakes Rudolf, Baringo, and Edward by an expedition from Cambridge University under the leadership of Dr. Worthington. Incidentally, problems in physical geography, limnology, and ecology are being studied, and data are being gathered concerning the native fisher folk.

ASIA

Quantitative Seismology in Japan. A nation which, previously far advanced in art, entered upon science less than a century ago, is now publishing elaborate quantitative investigations of the highest value in the difficult subject of seismology. The report "Topographical Changes Accompanying Earthquakes or Volcanic Eruptions [in Japan]" (Publs. Earthquake Investigation Committee in Foreign Languages, No. 25, Tokyo, 1930), much delayed in its appearance by "circumstances unavoidable," has been prepared by Akitune Imamura. It contains a remarkable body of critical observations and keenly interpreted facts, all stated in so condensed

a form that no brief abstract can do justice to them. The chief results concern the slight tilting of fault blocks in association with earthquakes, the movements of recent dates (twelve earthquakes since 1891) being determined by accurate triangulation and leveling as well as by changes of river courses and of shore lines; those of earlier dates as far back as A. D. 684 being inferred from topographic changes as described in historic records.

The tilting movements associated with severe earthquakes are thought to be divided into five stages: (1) practically no tilting for a century or more while seismic forces are dormant; (2) a slow tilting for several decades; (3) a slight tilting in the opposite direction for several months; (4) an acute increase of the latter tilting accompanied by an extensive and destructive earthquake; (5) slight tiltings in one direction or the other for several years until another dormant period sets in.

Brief accounts of a number of earthquakes are given. The great Mino-Owari earthquake of 1891 destroyed 142,177 houses with the loss of 7273 lives. The several faults then produced have been traced discontinuously across the entire breadth of the main island along a north-northwest course, from Ise Bay on the south to the Sea of Japan on the north. The displacements, which reached a maximum of six meters, are regarded as the result of seismic forces that had been growing for several centuries.

The effects of the great Kwanto earthquake of 1923, when Tokyo was so terribly afflicted, are set forth in considerable detail. Official records of destruction report 99,331 persons killed and 103,733 injured, besides many missing; 128,266 houses thrown down; 447,128 burned; and 868 on the seashore washed away by the *tunami*, or earthquake wave. The displacement of the chief quake-producing fault in the floor of Sagami Bay, 80 kilometers southwest of Tokyo, is estimated on the basis of 83,286 careful soundings at 100 meters. "The whole Kwanto district partook of a clockwise twist about a vertical axis somewhere in Sagami Bay." In the same district 15 minor faults have been traced.

W. M. DAVIS

AUSTRALASIA AND OCEANIA

The Dairying Industry in the Economic Transformation of New Zealand. "Go north, young man, go north" would have been the slogan of a New Zealand Horace Greeley in the nineties, says J. B. Condliffe, Research Secretary of the Institute of Pacific Relations. In his excellent book "New Zealand in the Making" (Univ. of Chicago Press, 1930) he describes the part of the shift in population from South Island to the virgin bush of North Island in effecting an economic transformation so sweeping as to be a veritable revolution. In 1891 of the total population of New Zealand 55 per cent was in South Island; in 1926 only 38 per cent. Progress in North Island during the first 40 years from the beginning of settlement had been comparatively slow. The drier and more open areas, such as the hinterland of Napier, were occupied by extensive sheep farms; but the wetter and richer lands, such as the Taranaki plain, were heavily forested and in possession of powerful Maori tribes. It was not till after settlement of the Maori wars in 1872 that these lands began to pass from aboriginal ownership.

New Zealand is well suited climatically to pastoral utilization. Equable and rainy, it presents similarities with the British Isles but is warmer and sunnier, as is well illustrated in a comparative table of rainfall, sunshine, and temperature included by R. G. Stapledon in "A Tour in Australia and New Zealand" (Oxford Univ. Press, 1928), or as may be gathered from E. Kidson's monograph "Average Annual Rainfall in New Zealand for the Period 1891 to 1925" (New Zealand Dept. of Sci. and Indust. Research, Meteorol. Branch, Wellington, 1930). In many parts of the islands all-the-year-round grazing is possible. But New Zealand, in contrast to its rival Denmark, suffers the disadvantages of a new country—small scattered

population and high cost of capital and, to an extreme degree, remoteness from markets. A solution of these difficulties has been found in localization in the most favored spots and in development of new technique of industry (see R. Ogilvie Buchanan: Geographic Influences on the Dairying Industry of New Zealand, *Geography*, Vol. 15, 1930, pp. 630–640). Refrigeration, of great importance to the sheep-raising industry, "rendered an even greater service . . . in creating a whole new export industry." Exports of butter, valued at £42,000 and of cheese at £7000 in 1883, rose to £11,303,000 and £6,694,000 respectively in 1928. Mechanization on the farms has been of enormous help where labor is scarce and expensive. The Dominion, well favored as regards hydro-electric power resources, has "the most fully developed and perfectly organized rural reticulation in the world," whose effects are most evident in the dairying industry, especially in Auckland and Taranaki (R. Ogilvie Buchanan: Hydro-electric Power Development in New Zealand, *Geogr. Journ.*, Vol. 75, 1930, pp. 444–461).

FIG. 1—Distribution of dairying in New Zealand. Note the concentration about Auckland and round Mt. Egmont, including the Taranaki country (New Plymouth is the chief center). After R. Ogilvie Buchanan in *Geography*, December, 1930, p. 631.

As regards primary production dairying remains a small-scale industry, attractive to the settler with small capital. In secondary manufacturing and commercial organization, on the other hand, it has become an efficient large-scale industry. The New Zealand dairy factories are the largest in the world. In the Taranaki region, according to Mr. Stapledon, no farm is more than three miles from a factory. Dairying permits of close settlement. "A concomitant to thriving dairy districts is the springing up of well balanced, small and self-contained little townships . . . examples of these rural cities are seen at their best in . . . New Zealand—Stratford in the Taranaki country immediately comes to mind as a model little centre (population about 3000)." Also associated with the dairying industry is the growth of secondary ports. Outside of the four main ports six other ports (1926) exported over a million pounds' worth of produce, reflecting a decentralization of economic life "of the utmost importance and value" (Condliffe).

While less sensational in its development the sheep-raising industry has made steady progress, as may be seen from the special article on livestock production (1901–1902 to 1926–1927) published in the New Zealand Official Year-Book for 1929. (See also Production and Trade of the Dominion of New Zealand, Empire Marketing Board, London, July, 1930.) As H. Belshaw has put it in his contribution "Farm Production and Population in New Zealand" in "New Zealand Affairs" (Inst. of Pacific Relations, New Zealand Branch, Christchurch, 1929), the prosperity of New Zealand is built on "foundations of grass." Mr. Stapledon concludes his book of fresh observation and shrewd comment with a chapter on the need for organized research for grassland study not only in New Zealand but in the British Empire at large. It is a subject that is engaging much attention. The Economic Advisory Council [Great Britain] has just published the sixth report of its Committee on the Mineral Content of Natural Pastures (1931), dealing with research in Kenya Colony. "Problems Relating to the Development of Grassland," by A. E. V. Richardson (*Journ. Council for Sci. and Indust. Research*, Vol. 2, 1929, pp. 5–15), states the general case for Australia. The successful integration of research is illustrated by two recent papers in the *New Zealand Journal of Science and Technology*, bearing on the relation between soils and animal nutrition: "The Relation of Geology to Sheep Sickness in Mairoa District," by N. H. Taylor (Vol. 12, 1930–1931, pp. 1–10) and "Volcanic-Ash Showers," by L. I. Grange (*ibid.*, pp. 228–240).

The Production Problem in Tasmania. The report on the "Economic and Trade Conditions in Australia to December, 1930" (Dept. of Overseas Trade, London. 1931, p. 38) reiterates the earlier warning on the inherent weakness of the Australian position—that "there has not been in recent years that expansion of quantity production which one would normally expect in a young country. So long as values for her chief exportable products remained high, the cash return to the country was sufficiently high to conceal the real position, but even considering values alone the position in recent years has tended to become more and more unsatisfactory." As regards the smallest state of the Commonwealth the "Report on the General Question of Tasmania's Disabilities" (*Commonwealth Parliamentary Paper No. 108*, 1930) is illuminating. The evidence presented to the investigating committee dealt with the difficulties in the carrying on of agriculture, stock raising, dairying, fruit growing, hop growing, sawmilling, and the manufacture of calcium carbide, "nearly all of which industries already lean on the Commonwealth for support or are claimants for assistance." It was pointed out that agricultural methods in Tasmania are characterized by an extreme use of arable land for the production of cash crops at the expense of crops grown to restore fertility to the soil—88 per cent in Tasmania as compared with 50 per cent in New Zealand. The most important crop of Tasmania is the potato, which in an average year represents about 25 per cent of the value of all crops, including orchards. Yet on account of continual cropping on exhausted land the total yield and the yield per acre of this plant as well as of all cereals are rapidly declining. Hence the petition of the Tasmanian Government to the Australian Parliament for a double subsidy for the next five years.

In "The Productive Efficiency of Tasmanian Farming" (*Econ. Record*, Vol. 5. 1929, pp. 275–288) G. C. Billing contrasts Tasmanian and Australian production results and uses the example of New Zealand to urge a program of mixed farming based on dairying, which in Tasmania has apparently been able to hold its own in spite of poor pastures and scrub herds. Improvement of pastures is a matter of concern for the state Department of Agriculture, which points out some of the problems and suggests remedies in a pamphlet on "Grassland Farming in Tasmania" (*Tasmania Dept. of Agric. Bull. No. 6* (*N. S.*), 1930). Tasmanian soils are said to be extremely deficient in phosphate and lime.

However, the rugged topography, heavy rainfall, and poor soils of a large part

of the land limit the available agricultural area. Comparing the geological and physical maps with those showing the distribution of alienated land, livestock, orchards, and population, it is evident that most agricultural activities are confined to the central and the Derwent-Huon basins (Gordon L. Wood: The Tasmanian Environment, Melbourne, 1929). The southwestern "wastelands"—the source of most of Tasmania's mineral wealth—is a wild, inhospitable, and little-known region, the "Lost Province," occupying nearly 4000 square miles or one-sixth of the island (P. Ormsby Lennon: Western Tasmanian Wastelands, *United Empire*, Vol. 18 (N. S.), 1927, pp. 601–605). The problem of its utilization remains to be solved. The Forestry Survey undertaken by the Development and Migration Commission reports that "The very wet country on the west suffers from the presence of waste marsh lands called 'button grass plains,' and low class myrtle forest with a more or less heavy layer of peat on the soil. Such land, in its present condition, is not satisfactory for planting, and advice as to the best means of dealing with these comparatively large areas of waste land is now awaited" (Commonwealth of Australia Development and Migration Commission, Report on Afforestation and Reforestation in Tasmania, *Tasmanian Technical Report No. 4*, 1929, p. 11. See also A. C. Forbes: The Button Grass Plains of Tasmania, *Empire Forestry Journ.*, Vol. 8, 1929, pp. 268–272).

The Aboriginal Population of Australia Today and at the Beginning of White Settlement. The Official Year Book of the Commonwealth of Australia for 1930 includes maps showing the distribution of the aboriginal population for 1927 and 1788. The latest census, 1929, enumerates 61,801 full bloods and 16,629 half-castes, scattered over the entire area but concentrated in the northern portions. The generalized map of distribution in 1788 accompanies a special article "Former Numbers and Distribution of Australian Aborigines" (pp. 687–696) by A. R. Radcliffe-Brown, who has made a critical analysis of the estimates of earlier observers considered in relation to the districts occupied and territorial organization. He divides the aboriginals into tribes and subtribes, on the basis of languages and dialects, and hordes, the landowning groups—a classification elaborated in his article "The Social Organization of Australian Tribes" in *Oceania*, published by the Australian National Research Council (Vol. 1, 1930, pp. 34–63, 206–246, and 322–341).

He reaches the figure of over 250,000 as the minimum for the original population of Australia with "quite possibly, or even probably, over 300,000." The density apparently varied closely with the food supply. The number of square miles per aboriginal is estimated thus: Queensland, 6.7; Victoria, 7.6; New South Wales, 7.8; Tasmania, 10.5; Northern Territory, 15.0; Western Australia, 18.8; South Australia, 38.0. For the country as a whole the figure is 11.9 square miles per aboriginal. Excluding the million square miles of arid interior which can support only the sparsest population, the density may be one aboriginal for every 6.5 to 7.5 square miles.

POLAR REGIONS

A Norwegian Expedition to East Greenland in 1929. The coast between 70° and 75° N. is the best part of East Greenland, there being here in summer time open waters, large snow-free tracts, and relatively abundant game. This region has been visited by many scientific expeditions from several countries, but the Norwegians are the only ones who have economically exploited it, not counting a Danish attempt between 1919 and 1924 that ended in failure. Since 1908 the coast has been visited by many Norwegian sealers seeking walrus, musk oxen, bear, and white and blue fox. Data thereon are given by Anders K. Orvin in his account of the expedition of the *Veslekari* in 1929 (Ekspedisjonen til Østgrønland med "Veslekari" sommeren 1929, *Norsk Geogr. Tidsskrift*, Vol. 3, 1930, pp. 89–146).

The *Veslekari* sailed with three different parties on board: nine men doing research work under the auspices of Norges Svalbardog Ishavsundersokelser, ten hunters who were to be landed at different points on the coast of East Greenland, and seven men from the State Bureau of Harbors to be landed on Jan Mayen and brought back. Two topographers mapped the coast of East Greenland from Sabine Island to Geographical Society Island, a stretch of some 200 kilometers. The botanists made large collections of vascular plants and lichens, and the zoölogist of animals at sea and on land. The leader of the expedition carried out geological work. Ruins of Eskimo dwellings and graves and tent rings were examined at Cape Herschel, two miles west of Cape Borlase Warren, and at Cape Humboldt on Ymer Island. Eight musk-ox calves were rounded up and, together with ten others that were bought, were transferred to Spitsbergen, where they are reported to be doing very well, in contrast to the attempt of an Icelandic expedition to the region in 1929 to introduce musk oxen into Iceland. Reindeer occurred in great herds in the region about 1870, were still plentiful in 1892, and were last seen in 1899, evidently having been speedily exterminated by the Arctic wolf, which seems to have immigrated thither in the nineties but which is no longer numerous.

ERNST ANTEVS

The Arctic Expedition of 1930 on the Ice Breaker "Sedov." The expedition sent by the government of U. S. S. R. to the Arctic seas in 1930 under the leadership of Professor O. J. Schmidt, and with a large complement of scientists left the port of Archangel on the ice breaker *Sedov* on July 15. [See also the accounts in *Arktis*, Vol. 3, 1930, pp. 60–65, by W. Wiese and in *Priroda*, No. 11–12, 1930, pp. 1135–1154 and in *Petermanns Mitt.*, Vol. 77, 1931, pp. 57–61, by R. L. Samoilovich.] The expedition first visited Hooker Island (80° 19′ N., 52° 48′ E.) in Franz Josef (Fridtjof Nansen) Land. Here in Calm Bay a meteorological station had been established, and here a party under the leadership of the pedologist Ivanov relieved the party who had passed the previous winter there. A second house for a broadcasting station was erected. From Hooker Island the *Sedov* proceeded to Cape Flora and thence to Bell Island, inspected Leigh Smith's hut built in 1881, made the necessary repairs, and explored the southern part of the island. It proved impossible, however, to approach Wilczek Island because of heavy pack ice. The *Sedov* therefore returned to Alger Island. Here the buildings erected by the Baldwin-Ziegler expedition in 1900 were still standing, though in poor condition.

From Franz Josef Land the expedition took its course towards Northern Land, in order to ascertain the position of the hitherto unvisited and uncharted western shores of the island and, in case a landing could be effected, to establish a broadcasting and meteorological station and leave four persons there for the winter. On its way the ice breaker entered Russkaya Gavan on Novaya Zemlya, being the first steamship to do so. Soundings were made, and the shores of the bay were described. Here a fresh supply of coal was taken in from the ice breaker *Sibiryakov*. Among the driftwood on the beach the interesting find was made of a cork buoy containing Baldwin's report, 1902, to the American consul on the difficulties experienced by the expedition, which was at that time wintering in Alger Island. In spite of the lapse of twenty-eight years the note proved in an excellent state of preservation.

On the way to Northern Land an island was discovered (79° 27′ N., 76° 41′ E.) whose existence Wiese had anticipated from the study of the drift of the *St. Anna* during Brusilov's expedition in 1913–1914. It was fittingly named after him Wiese Island. The island was reached by sledge, and a botanical and geological survey was made. It had been initially intended to proceed to Northern Land along the 79th parallel; but this plan had to be given up, as the way was blocked by heavy ice and it was necessary to alter the course. After a difficult struggle, with days when

progress amounted to no more than two ship's lengths, open water was reached (76° 43′ N., 79° 31′ E.). In the south a somewhat mountainous island was sighted, which was named Isachenko Island after the writer, who was botanist and microbiologist of the expedition. A second island, named Voronin Island, after the captain of the *Sedov*, also could not be approached because of the ice. The shores of Northern Land now became visible, and a search was begun for a place where a landing could be made in order that the building material for the erection of a broadcasting and meteorological station might be unloaded. Eventually a place was found in 79° N., near the Kamenev group of islands; and after a short time a house and a mast for short-wave transmission were erected. Four men were left there for the winter, including Ushakov, who had spent three winters in Wrangel Island, as leader, and the geologist Urvantzev, explorer of the Taimyr Peninsula. On August 31 the ice breaker began the return trip, first forcing her way northward as far as an island in latitude 80° 58′ N. This island, which is covered with an enormous glacier, was named Schmidt Island. On its way homeward the ice breaker steered southward in the direction of Lonely Island; but here, too, the strength of the ice prevented farther progress. The course was therefore shifted westward towards Novaya Zemlya. Archangel was reached on September 14.

The entire distance covered in the voyage amounted to more than 6000 kilometers, partly in regions never before visited. In addition to the discovery of several islands the outline of the western shore of Northern Land was traced, and a wealth of data brought back.

B. ISACHENKO

PHYSICAL GEOGRAPHY

The Measurement of Snowfall in Mountain Regions. Studies of precipitation in mountain regions may throw much light on problems of stream flow, floods, and irrigation in the neighboring lowlands. Difficulty, however, has always been encountered in obtaining satisfactory records of snowfall from high altitudes. Systematic daily readings of snow gauges widely scattered over uninhabited mountain tracts are obviously impossible, and measurements of the depth, density, and structure of the snow cover give at best rough approximations only of the snowfall over any given period. A possible solution of this problem, however, is suggested in a recent paper by Dr. Umberto Monterin on experiments recently carried out under his direction in the neighborhood of Monte Rosa. ("Ricerche sul funzionamento dei pluvionivometri totalizzatori in alta montagna," *Boll. Comitato Glaciol. Italiano No. 9*, 1929, pp. 235–251). These experiments tend to show that an improved type of "totalizator" snow gauge gives an even more accurate record of snowfall than the ordinary rain and snow gauge (*pluvionivometro*) which has to be read at frequent intervals. The totalizator was invented by the Savoyard forest inspector P. Mougin about 1910 (see the report of the Service des Grandes Forces Hydrauliques, Regions des alpes et du sudouest, *Études glaciologiques*, Vol. 3, pp. 92ff., as cited by J. Maurer in *Meteorol. Zeitschr.*, Vol. 32, 1915, p. 18). In this gauge the snow falls into a solution of calcium chloride and is melted even at temperatures as low as −25° C. Evaporation is prevented by a film of vaseline oil. The great merit of the totalizator gauge is that it preserves in liquid form the snow and rain that falls over a long period and hence can be installed on remote mountains where it need not be visited except at intervals of two or three months or more. The use of this type of instrument might well be studied as a possible means of supplementing observations of the type carried out in the mountains of New England in July and August, 1928 (*Geogr. Rev.*, Vol. 19, 1929, pp. 150–151).

HUMAN GEOGRAPHY

Some Recent Linguistic Studies of Geographical Interest. In his "Les langues dans l'Europe nouvelle" (2nd edit., Paris, 1928) Professor Antoine Meillet writes

that there has never been greater diversity of written languages than at the present time, nor less linguistic originality. "The intellectual treasure of humanity has not been enriched [by the multiplication of tongues]; there has been merely an increase in the number of banal ways of saying the same thing." During the Middle Ages Latin was the sole "language of civilization" in Europe. Recent times have seen a bewildering rise of national tongues, in which western and eastern Europe have shown contrasting developments. In the west the standard forms of modern English, German, French, Italian, Spanish, Portuguese, each essentially urban in origin, are everywhere tending to sweep away the local modes of speech. Country folk are imitating the urban standards, and their *patois* are losing their special characteristics. Very different is the situation in the great zone that stretches from Finland to the Balkans and eastward into Russia. Here the emergence of new nations at the close of the World War, the transfer of political power to the hands of rural majorities, and the interests of propaganda have raised obscure tongues to official dignity. In the east-central European zone west of the Soviet border, however, the speech of the peasants has nowhere entirely superseded the established tongues of the cities, with their long literary traditions behind them, and this zone constitutes "the domain of linguistic minorities and majorities and of the quarrels to which they give rise."

Meillet points out, further, that most discussions of linguistic frontiers are futile, because the disputants know nothing of linguistics. These frontiers are of two types. Starting from widely separated centers two distinctive languages may spread out and ultimately come in contact with one another along a sharp and clean-cut line. A frontier of this sort may be marked with great precision on a map: as between French and Flemish in Belgium or between French and German or German and Italian in Switzerland. Linguistic frontiers of the second type separate areas over which there are spoken divergent forms of what was once a single common language. Here, unless historical accidents have intervened to displace the population, no lines can be drawn. The frontiers form, rather, zones of transitional modes of speech that partake of the characteristics of the adjacent languages but cannot be definitely ascribed to them. Macedonia is a classical example. "Although the politicians have claimed the various tongues of Macedonia for this or that group, disinterested linguists may only reserve their opinion. In reality these tongues do not properly belong to either one or the other of the groups that dispute over them. . . . It is puerile to invoke linguistics in frontier questions of this order. Politics alone will decide the linguistic future of Macedonia."

The new edition of Meillet's work includes a helpful statistical analysis by L. Tesnière of the languages of Europe and of the world. The volume as a whole (including Tesnière's figures) is summarized by Professor Albert Demangeon in *Annales de Géographie* (Vol. 38, 1929, pp. 427–438).

Meillet has edited the coöperative work "Les langues du monde" with Marcel Cohen (Paris, 1924). In this and also in Wilhelm Schmidt's "Die Sprachfamilien und Sprachenkreise der Erde" (Heidelberg, 1926), the languages of the world are classified and described. Both are accompanied by maps showing the distribution of languages in each continent. A paper contributed by Professor Eugen Oberhummer to the Hermann Wagner memorial volume (*Petermanns Mitt. Ergänzungsheft No. 209*, 1930, pp. 253–264) is a statement of various ways in which linguistic studies bear upon geography and a critique of recent maps and monographs in this field.

OBITUARY

Alfred Wegener. Professor Alfred Lothar Wegener, who perished on the Greenland ice cap, was distinguished as meteorologist and explorer but probably was even more widely known for his theory of continental drift.

He was born in Berlin, November 1, 1880, and entered the field of exploration in joining the Danish Northeast Greenland Expedition of 1906–1908 as meteorologist. His studies included kite and captive balloon observations, the first upper-air studies of any kind made upon the Greenland east coast. On this expedition he had formed a close friendship with Captain, afterward Colonel, J. P. Koch which was to endure through life. Together Koch and Wegener planned an expedition to cross Greenland from east to west along its widest section, an enterprise carried through in 1913 with results of the first importance to science, though publication of the full report was delayed until 1930. In 1919 Wegener became division president of the German Oceanographical Institute at Hamburg, and in 1924 he was called to the University of Graz, Austria, as professor ordinarius of meteorology and geophysics.

In 1929 Professor Wegener made a preliminary expedition to West Greenland in order to lay out the route and to test out the equipment for his great expedition of 1930–1931, a primary object of which was to establish an aerological station in the remote interior of Greenland in comparison with stations on the east and west coasts. On this preliminary expedition results of exceptional importance were achieved, notably the determination of the recession of the glacier fronts over a period of as much as thirty years and a sounding of the inland ice, the first ever made. In coördination with other expeditions Wegener in 1930 was able to establish aerological stations according to his plans, and it was in a heroic attempt to provision and equip his remote central station and to conserve the lives of his men there that he sacrificed his own in November, 1930.

Because so many of his important studies have been made in Greenland and in several cases as a member of Danish expeditions, a considerable number of Professor Wegener's more important publications have been issued in the Danish *Meddelelser om Grønland*. These are "Drachen-und Fesselballonaufstiege ausgeführt auf der Danmark-Expedition 1906–08," 1909; "Meteorologische Terminbeobachtungen am Danmarks-Havn," 1911; (with W. Brand) "Meteorologische Beobachtungen der Station Pustervig," 1912; (with J. P. Koch) "Die Glaciologischen Beobachtungen der Danmark-Expedition," 1912; (with J. P. Koch) "Wissenschaftliche Ergebnisse der Dänischen Expedition nach Dronning Louisesland und quer über das Inlandeis von Nordgrönland, 1912–13, unter Leitung von Hauptmann J. P. Koch," 1930. His important expedition of 1929 was described in the *Zeitschrift der Gesellschaft für Erdkunde du Berlin* of 1930 under the title "Deutsche Inlandeis-Expedition nach Grönland, Sommer 1929," and in a popular work entitled "Mit Motorboot und Schlitten in Grönland," issued in 1930. Wegener also published "Thermodynamik der Atmosphäre" in 1911 and "Die Entstehung der Kontinente und Ozeane" in 1915, which has gone to a fourth edition and been translated into English and French. With his father-in-law W. Köppen, Wegener published in 1924 "Die Klimate der geologischen Vorzeit." Professor Wegener's specialty was the physics of the atmosphere, but the wide range of his interest is indicated by his works on continental drift and on moon craters, and he ranks among the greatest in the field of polar exploration.

W. H. Hobbs

GEOGRAPHICAL REVIEWS

On the Northern Frontier of New Spain

Herbert E. Bolton. **Anza's California Expeditions,** Vol. 1: **An Outpost of Empire,** xxi and 529 pp.; Vol. 2: **Opening a Land Route to California,** xii and 473 pp.; Vol. 3: **The San Francisco Colony,** xviii and 436 pp.; Vol. 4: **Font's Complete Diary,** xiii and 552 pp.; Vol. 5: **Correspondence,** xviii and 426 pp. Maps, ills., index in each volume. University of California Press, Berkeley, 1930. $25.00. 9 x 6 inches.

Professor Bolton's publications are milestones on a clearly marked road, a road he has been traveling for more than a score of years in robust good humor and tireless industry. Today he is not only a dominant figure in Hispanic American history but also one uniquely significant to the field of historical geography by the ever growing mass of sources and syntheses which he has published on the northern frontier of New Spain. His greatest interest lies in exploration and in colonization, in newly found lands and their appropriation by Spanish institutions. He speaks therefore directly to the geographer in a manner that the more conventional historian does not. For another physical environment and another culture he has carried on the frontier tradition of F. J. Turner.

The first two chapters of the first volume, "The Empire" and "Fringes of Empire," contain Bolton's latest interpretation of this long Spanish frontier, its origin, movement, and arrest. The first volume as a whole is a study of the secular side of frontier expansion, as the other side was expressed by him earlier in the memorable address on "The Mission as a Frontier Institution in the Spanish-American Colonies" (*Amer. Hist. Rev.*, Vol. 23, 1917). Bolton views the Spanish frontier as a deep zone, which North Americans are likely to misinterpret by attaching too much importance to what happened on the extreme fringe, which was only an audacious skirmish line. There is a clear perspective of the whole Spanish frontier movement in his earlier syntheses, "The Spanish Borderlands" (Yale University Press, 1921) and in "The Colonization of North America" (with T. M. Marshall, Macmillan, 1920).

The work which Bolton most likes to do and which seems to me to be his most lasting contribution is the gathering, translating, and editing of major documents. The first of these series was begun by him under the title "Spain in the West" (first volume, 1914). In this series he issued in 1919, as two volumes, "Kino's Historical Memoir of Pimería Alta," an important record of the great missionary cartographer who planted the beginnings of civilization in Arizona. The series of which the Anza volumes are the latest began in 1925 with "Arredondo's Historical Proof of Spain's Title to Georgia," the introduction thereto being also published under the title "The Debatable Land." In 1926 followed "Fray Juan Crespi, Missionary Explorer on the Pacific Coast," and in 1927 the four volumes of "Palou's Historical Memoirs of New California." The Anza set concludes publication of the major contemporary representations of Upper California. In it are included fourteen diaries, twelve of which are printed for the first time in any language.

As a contribution to historical geography the series of documents promises to rank with and in some respects to surpass Thwaites's "Early Western Travels," with which the comparison suggests itself. The materials published, with slight exceptions, have not been available previously in English; the majority of the documents have not been published in Spanish. The Spanish government and the missionary

orders had a remarkable personnel of explorers, who were meticulous and shrewd observers of the lands and peoples they encountered. The quality and detail of these Spanish observations in general are superior to the contemporary Anglo-American records, since friar and captain alike were official surveyors, required to present elaborate reports on routes traversed and people encountered. Geographically the Spanish-American colonial literature is in a class apart from that available for most of the colonial background of North America. Not only does Bolton know the whole sweep of Spanish-American colonization as does perhaps no one else, but he has an extraordinary flair for the geography of exploration. It is his pastime to trace explorers' routes on the ground. With transcript of documents in hand he has wandered over the whole southwestern United States and northwestern Mexico, reconstructing routes followed by explorers and locating camps and settlements. Thus he has followed in the field the entire course of the Anza expeditions, which are presented by an excellent series of maps. Tracing Anza's routes across the desert of the lower Colorado was a task which would be no holiday job even for a resident of the country.

Anza was the discoverer of the overland trail from Sonora to California, later to be of great importance. For six hundred miles, the most difficult desert stretch, he took the first white men over this trail. In his second journey he led the large, first colony of settlers to California, from Sinaloa to Monterey, with the loss of only one person, a woman dying in parturition. "This," Bolton says, "is a remarkable record, never excelled—perhaps never equalled—in all the history of the great pioneer trek of peoples to the Pacific Coast." The story of Anza and his companions is dramatically moving in these sober documents. Bolton pays a well merited tribute to the captain and his company, so adequately summing up the records that it shall be quoted in part:

"Few episodes in early American history are so well documented as these Anza expeditions. In the diaries and correspondence we learn the actualities of path finding and of colony leading. The records of distances and natural features are so accurate and vivid that one can retrace the whole trail, day by day, camp by camp. With this explicit information there is no need of romancing, for the realities were more stirring than fiction. Seen through the eyes of the participants, dependable water holes became matters of life and death. On the very weeds eaten by the pack mules might hang the fate of empire. The equipment which the colonists carried reflects the culture which they transplanted in the wilderness."

Bolton himself considers that he has little more than begun to exploit the treasure of Hispanic American frontier documents at his disposal. As colleague and friend, I wish that he may long continue to build this series which is his life work and his recreation, so that more of these excellent and little-known sources of history may come before a wider public through his competent and enthusiastic guidance.

CARL SAUER

PREHISTORIC AMERICANS

E. L. HEWETT. **Ancient Life in the American Southwest.** With an Introduction on the General History of the American Race. 392 pp.; ills., index. Bobbs-Merrill Co., Indianapolis, 1930. $5.00. 9½ x 6½ inches.

Through this volume a general survey of the Indian life and archeology of the Southwest is made available to the general reader in attractive and interesting style. It is justified not for the addition of any new scientific knowledge but as a general summary of the known field within a single volume.

Parts I and II, introductory to the main theme, deal with the present Indian and his culture. In Part III, which includes more than half the book, the author develops the theme suggested by the title but devotes most of the space to the areas

in which he and the School of American Research have made their investigations. The findings of other archeologists in other hardly less important areas are touched upon lightly, and some important recent investigations as in the Gila-Salt River watershed are not mentioned. The organization of this latter half of the book is based upon prehistoric cultures that conform to drainage areas as generally accepted by Southwestern archeologists.

Nearly as much space is given to the Rio Grande and Chaco Canyon cultures as to all the others, which is partly justifiable because of the greater amount of investigation in these areas; and in the case of the latter because of the living remnants of the Pueblo culture in the Pueblo Indians of today. The comparatively scant treatment of areas more remote from Santa Fe is disappointing, especially when the author digresses from the theme and, for instance, includes several pages of quotations expressing the emotional reactions of other authors to the Grand Canyon.

The conservatism in arriving at final conclusions is to be commended; for "American archeology, more than any other branch of the science, is paying the penalty of premature conclusions." The large amount of space devoted to the present-day Indian is justified, as the ideas of "vanished races" have been shown to be mythical. "The archeology of the American Southwest is the early history of the Pueblo Indians." Hence there is no adequate approach to the prehistory of the Southwest that does not begin with a study of present Indian cultures, particularly that of the modern pueblos.

The contrasts between European and Indian cultures are not flattering to us and are an eloquent plea for non-interference with social and religious practices, which when uprooted must also sacrifice the soul of the race, its integrity, and its self-respect. The author seems to idealize the Indian somewhat and generalizes traits of Pueblo culture as if they applied to all Indians. Certainly not all Indians, even of the Southwest, are to be held up as models for their relations with other tribes, for monogamy, or for sanitation; but the Indian has valuable social and cultural contributions to make if given the opportunity.

Hewett recognizes more than the average archeologist the importance of the physical environment in interpreting the cultures of the past and present; and to the geographer who is making a study of the Rio Grande region this source of general information should not be overlooked. Along this line is the author's earlier contribution in "The Physiography of the Rio Grande Valley, New Mexico, in Relation to Pueblo Culture" (*Bur. of Amer. Ethnology Bull. 54*, 1913). Climatic change, with inconclusive evidence, is stressed as the important factor in explaining the shift of cultural centers from the Pajarito Plateau to the valley proper of the Rio Grande. The Quivera and Pecos are important in a series of frontier settlements along the eastern mountain border, beyond which the Plains, with a mobile food supply, tended to perpetuate a nomadic life. "Certain favored spots became strongholds of the frontier." Other geographic correlations are made; many more need to be worked out, and Dr. Hewett's work may serve as a point of departure.

J. W. Hoover

H. C. Shetrone. **The Mound-Builders: A Reconstruction of the Life of a Prehistoric American Race, through Exploration and Interpretation of Their Earth Mounds, Their Burials, and Their Cultural Remains.** xx and 508 pp.; maps, diagrs., ills. D. Appleton & Co., New York and London, 1930. $7.50. 9½ x 6½ inches.

This volume presents a compendium of mound-builder archeology in popular form. The author distinguishes six types of culture areas; that of the lower Mississippi, with its truncated mounds, conventionalized designs, and occasional representations

of the plumed serpent, being most closely related to Mexico and that of the Great Lakes region being farthest removed in both distance and culture. Ohio, the best-known mound-builder area and the field of the author's own investigations, serves as the nucleus of the volume. Within that region three major subdivisions have been distinguished—the Adena, Fort Ancient, and Hopewell cultures, the last being the most highly developed native culture north of Mexico.

Stone sculptures, bone carvings, and pottery of the Hopewell culture and some of the southern groups have been surpassed by no similar objects produced by any people in the stone age stage of development. Ruins of village sites show that a high degree of specialization and division of labor had developed in both art and industry, and at least one mound-builder village, represented by the Cahokia Mounds in Southern Illinois, occupied an area that approximates that of a modern city.

The author accepts the theory of the Asiatic origin of the mound builders, their migration down the Pacific coast to Mexico, and their subsequent northeasterly movement. He suggests the possibility of migration by sea across the Gulf of Mexico. The mound builders are the racial ancestors of the historic Indians. The reason for the disappearance of their distinctive culture still lies in the realm of speculation.

History of the Vikings and Their Voyages to America

T. D. Kendrick. **A History of the Vikings.** x and 412 pp.; maps, ills., bibliogr., index. Charles Scribner's Sons, New York, 1930. $5.00. 9 x 6 inches.

Edward F. Gray. **Leif Eriksson, Discoverer of America, A. D. 1003.** xxxii and 188 pp.; maps, ills., bibliogr., index. Oxford University Press, New York, 1930. $7.50. 10¼ x 7 inches.

There has long been felt a need of a complete account of the viking period. Although many valuable books have appeared on this subject, they have dealt with it only in parts or else they have been too brief and schematic to give the reader a true picture of this remarkable migratory movement. Mr. Kendrick's book supplies this need in a well rounded harmonious description, starting from the partly legendary background prior to about the end of the eighth century, when the viking period proper commenced, and concluding the story at about the middle of the eleventh century.

The achievements of the three viking peoples, the Norwegians, the Danes, and the Swedes, in the course of little more than two hundred and fifty years are summed up by the author in the following lines: "The Norwegians created and owned towns in Ireland and possessed themselves of most of the Scottish islands; they colonized the Faroes, Iceland, and Greenland; they discovered America; at home they made themselves into a Christian nation united under one king. The Danes extended their authority over Frisia and won all England for their keeping; like the Norwegians they also had towns in Ireland and like them they too became a single Christian kingdom. In France a rich and pleasant colony was won from the Western Empire by Danish and Norwegian vikings. In the east the Swedes took large tracts of the East Baltic lands, they became lords of the Dnieper basin and founded the Russian state, they dared even to assail Constantinople and made commercial treaties with the emperors of the Greeks."

The vikings were not only barbarous robbers and invaders, they were also and perhaps primarily traders and colonists. Especially in the beginning the movement consisted in raids of a sporadic and opportunistic character, but gradually it assumed larger proportions, in several cases taking the form of great migrations, involving invasion and conquest of extensive lands. In some cases it took the form of a wholesale colonization of uninhabited lands. Thus it can be understood that while the

appearance of the viking in smaller private raids meant pillaging, murder, arson, and atrocities, the larger undertakings, such as the enterprises of Svein and Cnut, of the Swedes in Russia, and the settlement of Iceland, were free from the savage brutality of the smaller raids and had the character of great political events.

Mr. Kendrick, in his attempt to account for this amazing aggressiveness and output of energy finds the main causes in overpopulation and in the political conditions of the home countries; but he admits that these do not satisfactorily account for the phenomenon. It seems that the viking movement must be due primarily to the same cause as most other similar migrations in history. Whenever a civilized society is established, surrounded by or adjacent to barbarous peoples, there is created, so to speak, a potential: on one side wealth, luxury, peaceful living, indulgence, and a decline of the fighting spirit; on the other virility, courage, and other warlike qualities, developed in the hard struggle for existence under primitive and perhaps nomadic living conditions. This potential tends to discharge itself along the line of least resistance. Sometimes mountain ranges and wildernesses form barriers difficult to cross, sometimes artificial obstructions, such as the Chinese Wall, are put up in defense. The sea in many cases forms an effective barrier; but, when shipbuilding and seamanship reach a certain stage of development, it is transformed into an unobstructed highway, which at once opens easy access to all countries bordering on the sea. This is what happened to the Scandinavian peoples perhaps long before the viking period proper had begun. All the European coasts lay open to them, and probably trading was early established; but it happened that at the end of the eighth century and in the following two hundred years the civilized nations of Europe were in a state of political turmoil and weakness and were attacked simultaneously by other and even more dangerous enemies. The hardy seafaring people of the north soon realized that they could fall upon the defenseless inhabitants of the coasts with relative impunity, and they turned from traders to robbers.

While the political structures created by the vikings were soon largely overthrown, there remained, as pointed out by the author, one contribution to Western society that is hidden to the historian: "For who is to say of what significance either in the past or even in the present is the Scandinavian or Danish blood pulsing in the veins of Saxon, Frank, or Celt? . . . it may be that the judgement of the future will declare the vikings not only harmful and villainous guests in the lands of the Celt and Saxon and Frank and Frisian, but as lion-hearted visitors whose destiny it was to fan the embers of western Christian civilization with the cold winds of the north and kindle from them once more a bright and vigorous flame."

Numerous references and a bibliography facilitate further study beyond the framework of this excellent and inspiring book.

"A History of the Vikings" forms a fitting introduction to Mr. Gray's book on the Vinland voyages. It enables the reader to see these voyages in their true perspective as the last westward expansive effort of the viking nations.

The primary sources of information of these voyages are found in two volumes, Hauk's Book, containing the "Saga of Eric the Red," and the Flatey Book, in which is interpolated the "Tale of the Greenlanders." These two versions differ materially and are obviously the result of an intermingling of original sources. Any attempt at disentangling the confused and conflicting tales presented in those versions must begin by determining their relative historic value. This is what Mr. Gray has done with boldness and logic. He holds that the Flatey Book version is the more reliable and bases his opinion partly on the ground of internal evidence of the saga, partly on external evidence of contemporary history. He finds that the weight of common sense and human nature is on the side of the Flatey Book rather than on the side of the Hauk's Book. The "Tale of the Greenlanders," apparently written in Greenland, tells us of six voyages, nearly all commanded by Greenlanders. The "Saga of Eric the Red" tells of three voyages in which the Icelandic element among the

leaders is predominant. "In the Greenland version, the Greenlanders are given the chief credit: in the Iceland version, the main share of the honour and glory goes to Icelanders." Mr. Gray thinks it reasonable to suppose that the chief events of the Greenland version would survive there in verbal tradition longer than in Iceland and that then, when finally reduced to writing, the Greenland narrative would be simpler and less distorted in form than the narrative taken down in Iceland.

This view had been adopted already by the reviewer (The Voyages of the Norsemen to America, 1914) and Mr. Gathorne Hardy (The Norse Discovery of America, 1921) although neither went quite so far in depreciating the value of the Iceland version.

Based on this conception of the sagas the author has succeeded in producing a general picture of the events that on the whole seems logical and convincing, although complete agreement between the views of any two students will probably never be attained.

The book will be welcomed by all students of the Vinland voyages. It is a scholarly treatise, free from fantastic ideas, and forms a valuable contribution to the discussion of these explorations. It will be enjoyed also by all ordinary readers on account of its easy and entertaining style, enlivened by the enthusiasm of the author.

WILLIAM HOVGAARD

DID COLUMBUS SEEK TERRA AUSTRALIS?

CECIL JANE, transl. and edit. **Select Documents illustrating the Four Voyages of Columbus, Vol. 1: The First and Second Voyages.** clv and 188 pp.; maps, portrait, bibliogr., index. *Hakluyt Soc. Publs.*, Ser. 2, Vol. 65. London, 1930. 9 x 6 inches.

CECIL JANE, transl. and edit. **The Voyages of Christopher Columbus: Being the Journal of His First and Third, and the Letters Concerning His First and Last Voyages, to which is added the Account of His Second Voyage written by Andres Bernaldez.** 347 pp.; maps, index. Argonaut Press, London, 1930. £2, 2s. 10½ x 8 inches.

It is a curious trait of human nature which demands that the greatness of a man's deed or discovery shall be matched by the corresponding greatness of his intellect, moral worth, spiritual insight, even lineage! It is thus that a legend is built up around the author of a great discovery until he is fitted with all those attributes that to his particular age are the notes of a great man, whereupon efforts to see him as he was are stigmatized as jealous detraction.

Columbus is the Great Discoverer *par excellence*; although, judged as an exploit apart from its cosmic significance, his first voyage entailed far less danger and hardship than Magellan's first Pacific crossing: it was less hazardous, indeed, than those voyages regularly undertaken far beyond the Arctic Circle by the fourteenth-century English fishermen in their unwieldy cogs. The modern world, however, tends more and more to grant to the discoverer his meed of admiration and respect as man rather than as hero; and it is for this reason that a wide public, alike in America and in England, will turn with pleasure to the two carefully translated and edited volumes under review. Here one can read the story of the discovery of America as nearly as possible at first hand, and here one can find material for building up an authentic picture of Christopher Columbus himself.

Mr. Cecil Jane is already well known for his studies in Columbiana, but in his introductions he has decided, probably wisely, hardly to touch upon the main controversial questions but to guide the general reader through the intricacies of the great story as he himself reads it.

He agrees with the majority of critics in rejecting the account of Columbus' early life that took shape in the writings of Ferdinand Columbus and Las Casas and

accepts as most probable the view that the Genoese wool-weaver's son gained his first experience of the Atlantic Ocean in a mercantile capacity, buying and selling commodities for a Genoese merchant house. He declines to see any significance in Columbus' marriage to Felipa Moniz, even throwing doubt on the lady's relationship to the Captain Donatory of Porto Santo. The point is, after all, not very material, for a man of Columbus' intelligence and perseverance could certainly find means, during his business voyages, to possess himself of all that was known and rumored concerning discoveries in the great Ocean Sea. If he was book-learned before he first formulated his own plan, a supposition extremely unlikely, then he was aware of the theory, at least as old as Aristotle, that the capes of Asia to the east were not greatly removed from the capes of Africa to the west and that the distance to be sailed was hardly more formidable than voyages habitually accomplished, such as that from the Azores to Iceland of which Martin Behaim speaks.

If, however, Columbus gathered his cosmographical ideas from sailors and from sea charts, his thoughts would follow somewhat different lines: for, while it is true that every pilot of his day was instructed in the elementary knowledge of the sphere, the sea charts being drawn *in plano* led the user unconsciously to separate the east widely from the west, while at the same time they indicated the Atlantic itself, studded with mysterious islands, as a fruitful field of discovery. Mr. Jane dismisses these islands, including Antillia, as scarcely worthy of notice, although everyone familiar with medieval literature and cartography knows what emphasis was laid upon them, while he goes further and dismisses also the traditional view that Columbus "sought a way to the east by the west," replacing it by a startling hypothesis of his own for which he can hardly be said to advance one shred of authentic evidence.

This hypothesis, briefly stated, is as follows. Columbus, a religious mystic, conceived the idea that in the unknown hemisphere to the south were lands of great extent "peopled by a numerous, intelligent and civilized race, possessed of great material wealth and enjoying all the benefits of a developed and ordered society"—the words are Mr. Jane's own—and that these people he was divinely appointed to discover and bring to Christ. Now it was well-nigh impossible for a fifteenth century Christian to entertain such an idea, since it was a cardinal point of faith that all mankind were sons of Adam through Noah, whose descendants were dispersed through the tripartite world. Much of the faulty cartography of the fourteenth and fifteenth centuries is traceable to an attempt to fit observed facts to this theory, and Columbus' own unhesitating recognition of the people of Guahanani as "Indians" is fatal to Mr. Jane's view.

It is true that schematic diagrams of a symmetrical pair of habitable lands, the one in the north temperate, the other in the south temperate zone, were a commonplace of current textbooks on the sphere; but, even granted that Columbus had studied such a text, he would have read there the orthodox interpretation that, whereas both were theoretically habitable, one alone was actually inhabited. Nor, indeed, was the diagram treated as a strict representation of fact; it was followed always by an exposition of the actual disposition of the known land surface, just as in a modern textbook a schematic diagram of the planetary wind systems is followed by an exposition of the very different winds actually observed. Mr. Jane has mis-read the *Imago Mundi* if he finds in it any confirmation of his views (and while acknowledging the doubts that surround the Columbian "notes" he uses them when it suits his purpose): the peopled lands in the southern hemisphere that are there described, as for example Regio Patalis, are extensions of India and not separate land areas.

The controversy as to Columbus' objective hinges very largely on the current use of particular words and phrases. *Terra firma* did not mean a continent in the modern sense; it meant a part of the single known mainland, as opposed to islands of the Mediterranean and of the Ocean Sea. There were educated men of unorthodox speculation in Italy and elsewhere, whose thoughts flew to a "new world" on hearing

only of the first voyage of Columbus; but the Discoverer himself was not one of these, and Peter Martyr could still write in 1516, when in full possession of the records to date, "mille insulas: et uno *putato* continenti tres europas offeremus," which Richard Eden renders: "that great portion of earth supposed to be *part of the firm land*, exceeding in quantity three Europes."

Then, too, the term "discover" has given rise to misunderstanding. Mr. Jane, like many other critics, argues that eastern Asia, which he equates with Cathay and Cipangu, could not be Columbus' objective, because he could not set out to discover lands already known or described. Quite apart from the fact that the rich islands of Argyre and Chryse, King Solomon's Tarshish and Ophir, and Marco Polo's Locac, to say nothing of Paradise Terrestre, were all very desirable objectives in India beyond Ganges, the term "discover" is a relative one: Cipangu and Cathay were known only by very uncertain hearsay, and their true location remained to be discovered.

Space will not allow of a further detailed examination of Mr. Jane's views—interesting in the degree that they are provocative of argument—but a word must be said in defense of Peter Martyr and in criticism of the maps in the Argonaut Press volume. The Italian courtier was no inquisitive busybody but a serious historian who gained his information not, it is true, from documents but from careful first-hand inquiry of every competent pilot and educated observer that returned from the Indies. His judicious comments (e.g. in letters 133, 136, and 143 of the *Opus Epistolarum*) are of great importance in relation to Columbus' objective; and it is to be noted that he declared it to be "de percurrendo per *occiduos* antipodes" and not "australes." As to the maps, that in the Hakluyt Volume has been competently prepared by the Royal Geographical Society of London; those in the other volume have no network, no statement as to the projection employed, and, in the case of the most important of all, no scale. Thus they give no help in determining the exact course Columbus steered, nor are the maps consistent among themselves. While beautifully ornamented and executed they are a blemish from a geographical standpoint. They are, indeed, what a geographer would at once recognize as "historians' maps."

E. G. R. Taylor

The Sugar Industry in Cuba, Haiti, and Louisiana

Gustav Mikusch. **Kuba, Haiti und Louisiana als Zuckerländer.** 248 pp.; maps, ills., bibliogr., index. *Berichte über Landwirtschaft*, No. 21 (N.S.). Paul Parey, Berlin, 1930. M. 16.50. 10 x 7 inches.

Two separate and distinct aims are undertaken in this book. The first is to present a technical study of the sugar industry in each of the areas indicated. This the author does in a clear and concise style. In each a historical summary and a brief geographical description are first given. Then follows a statement of the present situation in the local sugar industry and the main problems of production with their underlying causes. The study is plainly not an exhaustive one; but Dr. Mikusch has, to a surprising degree, given an intimate picture of each of these sugar lands. He approaches each problem with impartiality and presents several opinions on the more important subjects, along with statistical data drawn from different sources. The reader is carried from the laborer in the field to the most technical operations of manufacture. Many comparative tables of sugar production —including volume and cost—for localities and chief world producers are included; also several excellent maps, such as the distribution of centrals and of damage by mosaic disease.

The second aim is to present a travelogue. This is delightfully done; and, although the author does not claim in any sense to be a geographer, his observations are

penetrating. The general mixing of casual impressions with technical studies possibly impairs the systematic value of the book but certainly adds greatly to its interest. Particularly interesting are observations made in the United States, which range from resentment at the treatment of the negro to gratification for the "short time necessary to cover great distances."

As the author was invited to make this study by Cuba, and as Cuba is much the most important sugar producer of the trio, it occupies nearly three-quarters of the book. The author denies that the sugar industry in that country is a primitive one, as is often stated, but says rather that the relatively low yields are the result of the extensive agriculture which is best suited to the present state of development in Cuba. Future improvement must be based on the development of irrigation, the systematic use of fertilizers, and scientific research in new varieties of cane and in disease control. Production costs on different classes of soils and in different parts of Cuba are comprehensively treated. The primarily important position of the *colonos* in the Cuban industry is clearly set forth.

The Republic of Haiti is hurriedly passed over, and the author decidedly is not favorably impressed either with present conditions or future possibilities.

The Dominican Republic is referred to as the oldest sugar area in the New World, and the history of cane production and present conditions are strongly contrasted with the Republic of Haiti. The overwhelming control by American capital and the transportation of raw cane to Porto Rico for crushing are among the interesting topics considered.

In Florida the manufacture of sirup and the use of the bagasse in the making of artificial wood are stressed. The use of machinery and the aid given by research institutes characterize the Louisiana industry.

ROBERT BURNETT HALL

IS SOUTH AMERICA A CONTINENT OF OPPORTUNITY?

CLARENCE F. JONES. **South America.** x and 798 pp.; maps, diagrs., ills., bibliogr., index. Henry Holt & Co., New York, 1930. $6.00. 9¼ x 6½ inches.

Mr. Jones, professor of economic geography at Clark University and associate editor of *Economic Geography*, devoted two journeys to South America and several years' research to preparation for this work, which is a necessary and valuable addition to the South American bookshelf.

The boundaries of economic geography are not well defined, and each author exercises liberty in selection of topics. The realm of trade Professor Jones has naturally excluded from this volume, as he had already dealt with it in his previous book "Commerce of South America" (Ginn & Co., 1928). The treatment of physical geography, climate, flora, soils, agricultural, pastoral, forest, and mineral industries, and the character and life of the rural population is comprehensive and thorough, with numerous illustrative charts, sketch maps, and photographs of value. Manufacturing is more briefly but still sufficiently dealt with. On the other hand, an economic geography of South America that omits such vital topics as fiscal conditions and heavy debt burdens, banking, currency and exchange, the influence of the Church, and urban life and development and that gives but scant treatment to politics, to the flow and effect of foreign capital, and to competition in world markets against certain South American exports can completely satisfy no one, however restrictive his views of the scope of economic geography.

There are six introductory chapters and one final chapter, "Progress," on the continent as a whole; and there are one or more chapters for each separate country, the Falkland Islands, Trinidad, and the Dutch West Indies. Due perspective in these regions has not always been maintained. So important an economic unit as Uruguay, for instance, receives 12 pages as against Chile's 42 and Colombia's 71;

and the historical introductions are uneven in extent and quality. Colombia, too, receives preferential treatment in the matter of photographs; a third of the pictures are Colombian.

The author wisely stresses the idea that South America is not a land, as often imagined, of golden future. The book is fundamentally an attempt to answer the question "Is South America a Continent of Opportunity?" (Ch. 1), and after well marshalling the evidence, the author sums up his conclusion as on the whole negative. With the exception of the temperate plains of the South, a few favored subtropical plateaus, and portions of the Cordilleras, the "other areas burdened by tremendous handicaps in all probability will not stage any remarkable advance for a long time, if ever." The humid tropic lowlands especially receive, and merit, condemnation. "The hope of a great tropical granary and storehouse seems little more than fancy."

After Mr. Jones's travels and researches ended, the present world depression set in or has become intensified and has furnished further proof of his thesis. He might today even tone down his favorable estimates. The past year has been a significant one for South America. Revolutions in four countries and the continued imminence of disturbance throughout the continent have profoundly altered political conditions. The foreign bond market has collapsed. Two countries have defaulted on their foreign debt. Others may default. Nearly all industries face a dubious outlook. Financial and valorization oxgyen cannot be administered indefinitely to countries moribund from a world overproduction of sugar, cotton, coffee, cocoa, wheat, minerals, etc. One-crop countries must find new export products or be hopelessly retarded; but to what shall they turn, and how? Mr. Jones, envisaging the whole world and not limiting himself to a too purely regional geography, had he chosen, might perhaps have offered constructive help for this pressing problem.

One of the minor defects of the book is its failure, except very rarely, to indicate when the author speaks from personal observation and when from hearsay. I welcome his direct observation that cacao trees in the Maracaibo district are too heavily shaded and therefore fungus-ridden (p. 621), but I should like to know whether the statements that gummosis and mosaic disease infest most sugar-cane areas in the Eastern Cordillera of Colombia (p. 599) and that sea breezes have a "cleansing effect" to render sugar cane less susceptible to disease (p. 679) are based on direct investigation; and I am more than skeptical of such evident hearsay as that cacao trees in the Yungas district of Bolivia bear 1000 pounds of beans (p. 260). Other instances could be cited.

Such an important and comprehensive contribution as Professor Jones has given us deserved more care in literary presentation.

PHANOR J. EDER

INDUSTRIAL LORRAINE: AN ECONOMIC AND SOCIAL GEOGRAPHY

AXEL SÖMME. **La Lorraine métallurgique.** viii and 249 pp.; maps, graphs, ills., bibliogr. Editions Berger-Levrault, Paris, 1930. 30 fr. 10 x 6¼ inches.

Although primarily industrial and sociological in character this study contains an abundance of geographical information, and by stressing the changing relationships between man and his environment in Lorraine it presents in an interesting manner the dynamic character of geography.

The work begins with a detailed discussion of the old iron furnaces of the region and shows how the construction of the railroads, the use of coal and coke for fuel, and the use of minette ores changed the location of these furnaces. The use of Lorraine ores did not, however, assume real importance until the discovery of the Thomas process which eliminated the difficulty caused by their high phosphorus content.

In considering the period before the World War the iron industry of each of the

Lorraine basins and of each of the neighboring coal regions is discussed in great detail. It is pointed out that the growing industry of the minette ore region early came under the financial domination of the older companies located in the near-by coal basins. The activity of Lorraine, however, differed from that of the coal areas in that the former was chiefly concerned with the mining of ore and the smelting of pig iron while the latter turned these materials into steel and finished products.

The post-war development of the industry in each of the Lorraine basins (Longwy, Nancy, Metz-Thionville, Luxembourg, Valley of the Orne) and in each of the coal regions is next given detailed consideration. The war ended the financial control exercised by the coal areas over the Lorraine companies and resulted in increased concentration and integration until the plants came into the hands of a few large companies controlled by French and Belgian capital. Another change was the increased emphasis on the production of steel and finished products. In the coal basins, on the other hand, it resulted in increased attention to the production of pig iron. There was also some change in the source of coal and coke used in Lorraine, an increasing amount coming from the French and Belgian fields although most still came from the Ruhr. This was accompanied by a sharp decrease in the export of minette ores to the Ruhr. In spite of these changes the coal areas are still chiefly concerned with the production of steel and finished products, while Lorraine is primarily concerned in exporting iron and large rolled steel products. The author indicates that future progress should be along the lines of increasing efficiency, of producing larger quantities of finished products, and of more fully exploiting the domestic market of France.

The several chapters devoted to the labor situation are of more particular interest to the economist and the sociologist. The many Italian and Polish laborers employed and the high birth rate among these peoples open some interesting speculations as to the future composition of the population. The possibilities of increased wages in the future may also somewhat reduce the present competitive advantage of the region.

The study concludes with a survey of the agricultural changes that have taken place in Lorraine and their relationship to the industrialization of the area. The most important change has been a decline in cereal production and an increase in dairying and other animal industries. The decline of the agricultural population and the shortage of agricultural labor are also considered.

In the appendix the author presents a valuable collection of tables, maps, and graphs showing the changes in industry and agriculture and in the location and character of the population that have accompanied the development of the iron industry.

J. F. BOGARDUS

THE PROBLEM OF JAPAN

JOHN E. ORCHARD. **Japan's Economic Position: The Progress of Industrialization.** Prepared under the auspices of the Council for Research in the Social Sciences of Columbia University. xvi and 504 pp.; maps, diagrs., ills., index. Whittlesey House, New York, 1930. $5.00. 6½ x 9½ inches.

E. F. PENROSE. **Food Supply and Raw Materials in Japan: An Index of the Physical Volume of Production of Foodstuffs, Industrial Crops, and Minerals, 1894–1927.** 75 pp.; graphs. University of Chicago Press, 1930. $2.00. 6¼ x 9½ inches.

The potential audience for Mr. Orchard's book falls naturally into two principal groups; those who, viewing the subject in a broad and general way, will want his conclusions; and the more serious student or the student in particular fields who will want the facts on which his conclusions are based. Fortunately both groups can be

satisfied; the former by reading Chapters 1, 2, 3, and 25, a total of less than 60 pages; the latter by reading particular sections or the whole 500 pages. This is another way of saying that the material is extremely well arranged—an important asset for a serious book of this kind.

Mr. Orchard begins his study with an examination of the pressure of population, which he regards as "the most fundamental problem of modern Japan." "It underlies most of the country's perplexing difficulties. It explains the efforts that are being made to improve agriculture and reclaim waste land, to develop manufacturing, and to expand trade. It is the basis of Japan's foreign policy." The population of Japan has doubled in the past sixty years, and now with a total of more than sixty millions it is increasing by 900,000 annually. Yet the increase of food has thus far kept pace. There has been no famine, and the standard of living has advanced. But to provide for this 900,000 increment 133,000 acres of new rice land must be brought under cultivation annually, or more than four times the acreage that has been added during each of the last twenty years. This is a process that cannot continue indefinitely. The Japanese "must turn to commerce or manufacturing, or they must seek a livelihood abroad. If these outlets prove impossible, Japan must either check the population growth or be faced with a heavier and heavier pressure on the means of subsistence and a resulting decline in the standard of living." Mr. Orchard sees a gradual change of view concerning birth control and believes that the difficult position faced by Japan will probably cause a complete reversal of government policy on the population problem and that positive checks on population growth will be advocated and actively encouraged. Meanwhile the possibility of relief by means of industrialization is being sought. Mr. Orchard, however, regards industrialization as more than a solution for the population problem. "It is the key to the future of the country. Unless there can be a very substantial development of manufacturing industries, Japan cannot hope to be a nation of first rank."

From this point of departure Mr. Orchard examines in great detail the industrial background of Japan and traces the history of the phenomenal industrial development of the last few decades. He includes an interesting chapter on the effects of the World War and then turns to discuss the supply of raw materials and of power. Poverty of these essentials "is the most fundamental weakness of industrial Japan. It is directing the trend of manufacturing development and it will set the final limits to industrial expansion." In the effort to present all the facts that may have a bearing on this problem the author has included chapters on the raw material resources of Manchuria and on China as a possible source of iron ore and fuel. Happily he has pointed out how unsuccessful the efforts have been thus far to get mineral supplies from China although they have been "valiant and persistent." "To an outside observer they would appear, on the whole, to have been ill-advised and futile. They are striking evidence of the crying need of Japan for iron ore and of the determination to secure it at any cost. The ventures in China have certainly been expensive and the results have not been very encouraging."

Labor on the other hand is plentiful, efficient, and cheap and "is the principal commodity that Japan is able to offer in international markets." Mr. Orchard analyzes the supply of labor and appraises its efficiency. He then traces the development of a labor movement and points to the gradually changing status of the worker.

In his final chapters the author explains the dependence of industrialization on foreign trade and analyzes the markets for Japanese exports. In his summary he goes to considerable lengths to persuade his readers that the menace of an imperialistic Japan in the Pacific is unjustified and that an "industrial yellow peril" is but a "bogey conjured up by ardent militarists, especially in the United States, to advance their demands for a large army and a large navy." Japan's poverty in coal, petroleum, and iron ore, the precariousness of Japan's financial position, and the depend-

ence of the country economically upon trade with the United States are all hostages to peace.

Mr. Penrose in his study of the production of food, industrial crops, and minerals has rendered a distinct service to the student who is unable to read Japanese. He has prepared in statistical form a picture of Japan's resources based on the physical volume of production from 1894 to 1927. His figures illuminate the striking weaknesses which Mr. Orchard so frequently noted. The figures are put forward by Mr. Penrose with commendable modesty and with the suggestion that "the results of a statistical investigation should be checked, analysed, and thoroughly tested by all other knowledge, some of it being of a non-statistical nature, relevant to the investigation in hand."

Mr. Penrose says nothing in his title about population, but in the first sentence of his introduction he states that "this study aims at tracing the relative growths in Japan of population, domestic production, food imports, agricultural production and mineral production." The figures have been reduced into index numbers for comparative purposes; and the final results have been put into a series of simple graphs that are most illuminating. It can be confidently predicted that this work will furnish the basis for studies in Japanese production for years to come.

The conclusions of Mr. Penrose, while more tentative in form than those of Mr. Orchard, are of the same general character. They are such as to make one wish for more rapid improvement in international economic coöperation so that a freer interchange of goods and services across national boundaries may have a larger share in solving problems that now seem so formidable.

WALTER H. MALLORY

COMMERCE OF THE ASIAN SHORES OF THE INDIAN OCEAN

VERA ANSTEY. **The Trade of the Indian Ocean.** xvi and 251 pp.; maps, diagrs., bibliogr., index. (The University Geographical Series.) Longmans, Green & Co., London, New York, Toronto, 1929. $3.00. 8½ x 5½ inches.

In "The Trade of the Indian Ocean," a text prepared primarily for use in schools of commerce, Mrs. Anstey has undertaken the study of an extremely complex area and one with few unifying factors other than the Indian Ocean itself. She has added to her difficulties by the selection of a title that is much too broad. In his introduction, Professor A. J. Sargent of the University of London has attempted to justify the treatment of the lands of the Indian Ocean as a unit on the basis of their common economic factors—European capital investment and the ultimate European economic control. But his contentions are not convincing; and in her opening pages Mrs. Anstey finds it necessary to eliminate entirely two of the Indian Ocean lands, South Africa and Australia, and experiences some difficulty in including Persia, Iraq, and British East Africa. The book is devoted mainly to the detailed analysis of the trade of India, Ceylon, Malaya, and the Dutch East Indies, a region with a considerable degree of unity. A recognition of that limitation in the title of the book would have given a much more accurate idea of its scope. The author is evidently much better informed on those parts of the continent, and it is in the sections of the book dealing with them that her real contributions are made.

Mrs. Anstey has assembled in one volume from many scattered sources a great deal of valuable information on the trade of the countries of southern and southeastern Asia. She has realized that the bare presentation of such information has little significance and has woven it into an interpretation of the economic background of the regions. Her analysis provides an understanding not only of the contributions of those lands to world trade but also of the principal occupations prevailing within them and of the problems that have been encountered in their development.

The first part of the book gives the economic background and details of trade:

the trade chapters, however, are not entirely satisfactory. They are based on the trade of single years, which may or may not be representative. A much sounder and a simpler method would have been the use of three-year or five-year averages for both the pre-war and the present period. The use of the different units of currency for the various countries discussed, without converting them to a common medium, increases the difficulty of the student. Numerous graphs are included, but they are somewhat clumsy in their construction and do not give a quick and vivid visual comprehension of the major developments of the trade. Too much important material has been relegated to footnotes, which break in on the continuity of the text and make hard reading—all technical faults, but important for a textbook.

The latter half of the book is a very intelligent and accurate analysis of the problems and accomplishments of large-scale industrial production and plantation production as organized by the Europeans in India, Ceylon, Malaya, and the Indies. The trade in plantation products and in minerals is discussed, the managing agent system is described, and the labor problems and the problems of overproduction and restriction in the plantation industries are clearly presented.

JOHN E. ORCHARD

NORWEGIAN WHALING AND EXPLORATION IN THE ANTARCTIC

BJARNE AAGAARD. **Fangst og Forskning i Sydishavet.** Vol. 1: **Svunne Dager**; Vol. 2, **Nye Tider.** xi and 1069 pp.; maps, ills., bibliogr., index. (Kommandor Chr. Christensens Hvalfangstmuseum, Sandefjord, Publ. No. 9.) Gyldendal Norsk Forlag, Oslo, 1930. 10 x 7 inches.

In his preface the author states that these two volumes were begun at the request of Consul Lars Christensen in 1927. Volume 1, "Bygone Days," gives a detailed account of the origin of Norwegian whaling in the Antarctic. After some discussion of the antecedents of this development there comes an interesting and lively description of the expeditions sent out by the originative and farseeing business man and shipowner, Christen Christensen, the father of Lars Christensen. These are the expedition of the *Jason*, Captain C. A. Larsen, in the season of 1892–1893, and of the *Jason*, *Hertha*, and *Castor* in 1893–1894, and the *Admiral* (the first floating factory in the Antarctic) in 1905–1906, the *Vesterlide* expedition in 1908–1909, and the *Tulla* expedition in 1911–1912. Mention is also made of the experiences of the Scottish whalers who lay at the same time as the *Jason* on the west side of the Weddell Sea in the season 1892–1893, and also of the expedition in the *Antarctic*, under the command of H. J. Bull, to the Ross Sea waters in 1893–1895 (the expenses being defrayed by the famous Norwegian whaler, Svend Foyn), and finally of Otto Nordenskjöld's Antarctic expedition in 1901–1903.

The most important of the Norwegian expeditions mentioned, from a geographical point of view, were those of the seasons 1892–1893 and 1893–1894, and the author in a special chapter gives a detailed account of the discoveries made during those expeditions. Not only from printed sources and journals but by personal application to living members of the expeditions, the author has succeeded in bringing forward much new information regarding them and the discoveries made by them. On the basis of his studies the author emphasizes the idea that it would be incorrect to apply any other name than Foyn's Land (or Island) to the land discovered by Larsen in 1893 and lying between Wilkins' Crane Channel and Casey Channel (p. 300). The present reviewer agrees with the author that it would be incorrect, as has been done in several recent maps of these regions, to limit Foyn's name to one or two small islands situated to the west of Veier (often erroneously called Weather) Island. The author has illustrated his views in a map showing the districts where C. A. Larsen made his discoveries in 1893.

The second volume of the work, "Modern Times," deals with the expeditions sent out by Consul Lars Christensen during recent years, viz. the cruise of the whaling boat *Odd I* to Peter I Island in January, 1927, and the three *Norvegia* expeditions, in 1927–1928, 1928–1929, and 1929–1930. Some account is also given of the fourth *Norvegia* expedition and its plans for the season of 1930–1931. Furthermore, the second volume contains an interesting chapter on Bouvet Island, its history, the British claims, etc. Although reports of most of these expeditions are to be found in geographical journals and, as regards the third *Norvegia* expedition, also in the form of a book written by the leader, Captain Riiser-Larsen, it is of value to have a collective and detailed account of these important voyages which, *inter alia*, are remarkable because they are all due to the initiative and generosity of a private individual. The reviewer has a few reservations to make. In his opinion the author has sometimes gone too much into detail. And, moreover, in the discussion of various geological and topographical features of the islands which were more closely investigated, viz. Peter I Island and Bouvet Island, some of the details are questionable. The work contains numerous illustrations. A large number of those in the first volume represent reproductions from earlier publications. Of those in the second volume, more than 300, many depicting the same thing might with advantage have been omitted. In some cases the title is also erroneous, the same landscape having been given a different geographical designation in the different illustrations (compare the illustrations on pp. 862 and 870; and that on p. 713 with other views of Cape Valdivia). The second volume concludes with an extremely comprehensive list of Antarctic literature, covering no less than 75 pages, and a list of works on whaling filling 35 pages. These valuable bibliographies would have been still more useful had they been arranged topically instead of alphabetically by author.

OLAF HOLTEDAHL

THE ANDRÉE POLAR EXPEDITION

Andrée's Story: The Complete Record of His Polar Flight, 1897: From the Diaries and Journals of S. A. Andrée, Nils Strindberg, and K. Fraenkel, found on White Island in the Summer of 1930 and edited by the Swedish Society for Anthropology and Geography. Translated from the Swedish by Edward Adams-Ray. xvi and 389 pp.; maps, diagrs., ills. The Viking Press, New York, 1930. $5.00. 9½ x 6½ inches.

Viewed from the standpoint of geographical discovery the Andrée Polar Expedition of 1897 was a failure. Nothing was added to the store of knowledge of polar conditions. Subsequent airplane and airship flights over the pole made important observations and verified the existence of a vast ice-covered sea, all of which came to be part of our established knowledge of the North Polar regions between the time of Andrée's departure and the time of the discovery of the remains and fate of the Swedish expedition, after a lapse of thirty-three years.

On the other hand nothing can detract from the Swedish explorers' record as the first scientific voyagers by air. They were pioneers and, like most trail blazers, were handicapped by faulty material. Andrée had calculated on a balloon capable of flotation for a long period—possibly a month. The record shows that his leaky gas bag barely sustained them for twenty-four hours. They bumped over the sea ice and deflated after a flight that was far from free, after sixty-five hours of heroic voyaging.

This book is a complete record of the Andrée Polar Expedition. It is dramatic as only the simple truth can be when the fates combine such elements of imagination, daring, and scientific idealism as went into the thirty-three-year mystery of the polar sea. The world had placed the name of Andrée with that of Sir John Franklin. A few messages had come back, one by pigeon and a few by buoy; but what the final

fate was seemed sealed forever. Then the startling discovery was flashed about the world, via radio, an art developed since the departure of the voyagers in 1897. The bodies of Andrée and his companions had been found on White Island. Seldom has so thrilling a discovery been recorded. And never has the material brought back been so completely revealing. Even the films, handled with matchless skill, yielded startling photographs to illustrate the story. The highest praise falls short of doing justice to the way in which the record of this expedition has been spread before us.

Anyone can now tell what should have been done. In the first place the balloon was utterly unfitted for a sustained flight anywhere, let alone over the Arctic ice. But Andrée and his companions felt themselves obligated to carry through. The handling of the balloon was capable. The landing, on the sea ice, was successful. Their great error was in starting toward land, in midsummer. They might easily have camped on the ice, with ample equipment and ample game, and have waited for more favorable traveling conditions. Their heart-breaking journey across the slush, on drifting floes, dragging sledges by man power through sticky mush and over incredible ridges must remain a record of superhuman effort.

Their fate, on White Island, remains an unsolved riddle. Vilhjalmur Stefansson, in the *Saturday Review of Literature* of January 3, 1931, draws the seemingly inevitable conclusion that death came to the survivors, Andrée and possibly Fraenkel (Strindberg seems to have died in advance of his companions), by asphyxiation. This seems to be borne out by the fact of their insufficient clothing.

Further than this, the gallant Swedes were inexperienced on the ice, hence their haste to return at an unfavorable season. Game was plentiful, they killed bear far from land. But, whatever may be said, the priority of their venture must be recognized; and they left a record that must always remain a monument to their scientific thoroughness and their heroic determination.

FELIX RIESENBERG

SEDENTARY BERBERS OF SOUTHERN MOROCCO

ROBERT MONTAGNE. **Les Berbères et le Makhzen dans le sud du Maroc: Essai sur la transformation politique des Berbères sédentaires (groupe Chleuh).** xvi and 426 and xv pp.; maps, indexes. (Travaux de l'Année Sociologique.) Librairie Félix Alcan, Paris, 1930. 75 frs. 10 x 6½ inches.

ROBERT MONTAGNE. **Villages et kasbas berbères: Tableau de la vie sociale des Berbères sédentaires dans le sud du Maroc.** ix and 22 pp.; map, ills. Librairie Félix Alcan, Paris, 1930. 50 frs. 10 x 6½ inches.

To the classic works of Hanoteau and Masqueray on the Kabyles of Algeria we may now add this book on their Moroccan counterpart, the Chleuhs, by Robert Montagne, formerly of the Institut des Hautes Études Marocaines, recently appointed director of the Institut Français of Damascus. "The Berbers and the Makhzen" is a penetrating analysis, historical and sociological, and by that token geographical, based on field work carried out during many years in a region virtually unknown. Supplementing it is the volume "Berber Villages and Kasbas," an album of fine photographs with a brief, clear text.

Today the Chleuh country—the High Atlas of Marrakesh, the plain of Sous, and the Anti-Atlas—is divided between three great cadis, the Glaoui, the Goundafi, the Mtougui, auxiliaries of the central government (Makhzen). Romantic figures they are, suggesting feudal chieftains, but as a matter of fact the great cadis are a recent creation. Their début dates back to the period 1860–1870. Their extension and consolidation in the first year of the twentieth century was favored by the troubles arising from the competition between the sultans Abd-el-Aziz and Muley-Hafid and the French conquest in which the cadis played an adroit part.

On the summits of the High Atlas, in the shut-in valleys, Montagne discovered little republics that have escaped the domination of the cadis. These represent the real Chleuh country, which Montagne has studied *con amore*. His detailed analysis cannot here be followed. Let it suffice to say that the political unit is a canton of an average width of fifteen kilometers governed by a council of nobles extremely jealous of their democratic equality. Similar political formations are well known among the sedentary Berbers in the Riff and Jurjura (Kabylia). Montagne, adopting an idea of Masqueray's, makes a comparison between these political entities and those of Mediterranean Europe 3000 years ago at the dawn of the city of antiquity; evidently the Berbers are the laggards of Mediterranean civilization.

Perhaps the newest part of the book is the analysis of the process by which personal power is spontaneously born in these little republics, so jealous the while of their democratic constitution. The phenomenon occurs in all the groups of sedentary Berbers. Abd-el-Krim furnishes a striking example from the Riff. In the Chleuh the great cadis are a simple recurrence of a historical phenomenon, common in the past, the *mahdi* of the Almohades for instance. But this personal power never lasts, it permits frightful abuses, it is only maintained by force, and the democratic instincts, deep-seated in the sedentary Berber, emerge in the long run.

A curious fact may be remarked. The Kabyles of Algeria have successfully resisted the Makhzen: it has not been able to swallow them up, for which reason Jurjura is so prosperous—more than 100 inhabitants to the square kilometer—and so individual.

The High Atlas of Marrakesh, on the contrary, has been many times overrun by the Makhzen—under the Almoravides, the Mérinides—and is still overrun today under our very eyes. It has not so well preserved its ancient characteristics: Montagne had to ferret them out in the isolated valleys. But this seems to contradict a geographical axiom. The High Atlas is a much more important massif than the Jurjura, and one would expect to find there the best conserved Berber group. Montagne shows us why this is not the case. The High Atlas like the Jurjura has sufficient water, but it lacks land. In this high mountain of naked alpine relief, soil is found only in the bottom of the valleys, little fertile pockets that have to be built up and held by great retaining walls. Levels of any extent are to be found only in the lower valleys where they debouch on the plain. It is the foot of the mountain that is important, the zone of large villages, known by a special term, the Dir. The high valleys, so little favored, are at another disadvantage: by the valley itself they offer communication with the plain, while at the same time they are isolated one from another. It is quite otherwise with Kabylia. The population shuns the valleys and groups itself in very large villages on the summits within sight and call of one another—a coherent group of fortresses that sultan and bey have never been able to force. The advantage of Kabylia lies in just that, its moderate elevation and relief.

E. F. GAUTIER

MEDIEVAL TRAVEL ACROSS THE ALPS

J. E. TYLER. **The Alpine Passes: The Middle Ages (962–1250).** 188 pp.; bibliogr., index. Basil Blackwell, Oxford, 1930. 8s. 6d. 9 x 6 inches.

This volume, written by a lecturer in modern history at the University of Sheffield, gives an account of the Alpine roads at an epoch when they had an importance, relatively speaking, perhaps never attained before or since. A knowledge of them is valuable historically for the understanding of such problems as the character of Rome's spiritual supremacy, Italian commerce, and the attempts of the German emperors to control Italy; and valuable to industrial geography in understanding how trade between north and south was effected at that time.

In writing the book the author had no such helps as the Antonine Itinerary (now

adequately edited by O. Cuntz, Leipzig, 1929) and the Peutinger Table for the older Roman roads. Consequently he has gathered his material from heterogeneous sources, such as notices in chronicles and itineraries. Some of the latter, however, are very valuable. The best of all is found in the annals of Albert of Stade, a veritable guidebook, which describes a journey taken in 1326 from Germany via the Mont Cenis Pass to Rome and for the return gives a detailed account—naming towns, rivers, mountains, and distances—of the St. Gotthard and Brenner passes and, as alternates, mentions the routes over the Great St. Bernard and Septimer.

The introductory chapters have the greatest interest for the general reader. Here are discussed such topics as the lack of road-building plans in the Middle Ages in contrast with those of the Romans before and those of Napoleon and others since. In the chapter on "The Ordinary Traveller in the Alps" the author graphically describes the difficulties of Alpine travel in those times from avalanches, storms, snowdrifts (of which he reproduces three first-hand accounts), the procuring of supplies, and robbery. He shows that robberies were mostly political, in the nature of tolls, a lucrative business indulged in at times by petty kings. Thus the need of inns and hospices to do the work earlier done by the monasteries was felt at the time of the Crusades, places, that is, where all classes of travelers—ecclesiastics, merchants, soldiers, actors, jesters, jugglers, strolling musicians, and others who frequented the roads for business but never for pleasure—could find food and shelter for themselves and their beasts. The pilgrim travel, always the most frequent, was international and included English men and women from the time of Ceduald, King of the West Saxons, who journeyed to Rome and died there in 689, and many Icelanders from the eleventh century onwards. A detailed account is given of the oldest of the hospices, that founded by St. Bernard of Menthon, Archdeacon of Aosta, in the eleventh century. By the thirteenth century it had lands in England, the Rhine Valley, and Apulia, mostly gifts of grateful travelers of note. In the chapter on "The Imperial Expeditions" are outlined the difficulties encountered by armies, especially in reference to their commissariat, which often necessitated the passage of one pass *en échelon* or in detachments over several, e. g. that of Henry V over the Great St. Bernard and the Brenner in 1110.

WALTER WOODBURN HYDE

GLACIATION OF THE TATRA

EUGENIUSZ ROMER. **The Ice Age in the Tatra Mts.** Maps, ills. *Mémoires Acad. Polonaise des Sci. et des Lettres, Classe des Sci. Math. et Nat.*, Ser. A, Vol. 1, 1929, pp. 1–253.

M. A. LEFÈVRE. **La morphologie glaciaire de la Haute Tatra.** *Rev. de Géogr. Alpine*, Vol. 17, 1929, pp. 747–755.

Romer's treatise of the Ice Age in the Tatra, a result of many years of investigation, differs greatly both in mode of reasoning and in conclusions from previous works on the subject in the Tatra and elsewhere. Perhaps the most unorthodox view is the belief that the old glaciers did not erode but rather conserved the land forms, while streams alone deepened the valleys during the interglacials.

On the northern side of the mountains, the side chiefly studied by Romer, traces of three separate glaciations have been distinguished in all the valleys. The oldest glaciation was most extensive, the youngest least so. The first two glaciations are recorded by deposits on small terraces and plateaus, the last glaciation alone by distinct moraines in the valley bottoms. Besides these well recorded glaciations, remnants of deposits belonging to a still older, fourth, and very extensive glaciation have been found.

Miss Lefèvre finds that the morphology of the Tatra is essentially due to two factors—the Quaternary glaciations and postglacial frost action. The most important

glacial features are the numerous cirques and the lakes they contain. The glacial topography is a cross between that in the Alps and that in Wales. The sharp ridges and deep, steepsided valleys remind one of the Alps on a small scale, while the abundant lakelets in the cirques and the total absence of modern glaciers recall the Welsh mountains. Postglacial river erosion has been negligible, but the higher regions of the Tatra have been considerably dissected and remolded by nivation and other phases of frost action. Physical weathering continues on a large scale, and so do movements of débris by frost.

ERNST ANTEVS

PHYSIOGRAPHY OF THE WESTERN UNITED STATES

NEVIN M. FENNEMAN. **Physiography of Western United States.** xiii and 534 pp.; maps, diagrs., ills., index. McGraw-Hill Book Co., Inc., New York, 1931. $5.00. 9 x 6 inches.

Everyone who has studied, taught, or investigated in the field any physiographic problems in the western United States must welcome Professor Fenneman's volume. It summarizes the information about a vast territory hitherto available only in a multitude of different sources, while the author's personal observation serves to clarify the ideas of the reader who is prone to find himself bewildered by the conflicting opinions of the numerous geologists and geographers who have studied portions of the western states.

The book treats the surface forms of all the states west of the eastern limit of the Great Plains. It deals with geology only so far as that is necessary to explain the present topography. Human geography is not treated fully, although to illustrate certain definite points some of the more direct effects of the topography on the life of man are described. These phenomena include mainly the relation between topography and climate which directly affects agriculture and grazing. Groundwater conditions are discussed because of their intimate relation to topography, but most mineral deposits are ignored as a field of study foreign to the subject. Of special merit are the block diagram maps of each province drawn for the book by Dr. Guy-Harold Smith and carefully showing the necessary place names. Blackwelder's excellent pictures of the desert regions, where photography is so difficult, are deserving of mention.

In general Fenneman has accepted without much question most of the numerous peneplains which have been suggested, but it must be realized that his interpretation of the word "peneplain" is liberal and that he allows a possible relief of 1000 feet in some places. Daly's objections to the interpretation of a relatively even sky line in a thoroughly dissected region as evidence of former low relief are dismissed rather summarily. On the other hand, technical terms are not greatly stressed. To the present writer this is a striking merit of the book, for the overemphasis on such terms, most of which by their very nature commit the user to a definite interpretation of origin, has been one of the causes for the striking loss of ground of physiography in secondary schools.

It must be realized that the information on which the work is based varies greatly in fullness and reliability. For instance, the Southern Rocky Mountain province is fully treated, but the Northern Rocky Mountains are so little known in detail that definite conclusions cannot be reached. The controversy over the age of the peneplains of the Northern Rockies is treated in an eminently fair and reasonable manner and is well illustrated by cross sections which show the several possibilities. Few generalizations, however, are attempted with regard to these rather complex and monotonous forested mountains.

In the treatment of the Great Plains the principal addition to previous works is the explanation and description of the Missouri Plateau or dissected northern

part of the plains. Fenneman's field studies of the eastern and southeastern boundaries of the province are also made available here in connection with a description of the entire region. The high plateaus of the Raton district are discussed as part of the Great Plains with which they properly belong.

The Columbia Plateau is treated in considerable detail. The fact is brought out that it is not necessary to assume "fissure eruptions," for there are enough volcanic vents to account for the lava flows. Fenneman has not expressed any opinion of his own in regard to the controverted mode of origin of the "scablands." He goes no farther than the acknowledged fact that they were caused by glacial meltwater.

The strong modern tendency to explain stream courses as due to superposition rather than to antecedence is exemplified in the discussion of the Colorado Plateau. Conservatism marks the discussion of peneplains postulated by others in this region of obvious rock control due to essentially horizontal strata.

In treating the Basin and Range province Fenneman has again displayed a broad point of view in acknowledging that not all the mountain ranges and accompanying valleys are of the same origin and in admitting the possible importance of wind erosion, or deflation. He seems to lean rather strongly to the view that many of the ranges are in their second cycle of erosion and that their borders are "fault line scarps" rather than young "fault scarps." The development of rock pediments is also explained. The net result is a decidedly different picture than that obtained from reading older texts.

Fenneman accepts the summit peneplain (or peneplains) of the Sierra-Cascade province, although he admits that the surfaces could never have been truly level and that "the observer who now sights over the ridges from one of their number has his flat horizon determined by lava flows more than by peneplain." Matthes' explanation of the Yosemite Valley is given to the exclusion of older ideas. Crater Lake is treated very briefly, and no evidence is offered as to its origin. The fiord-like bays of Puget Sound are explained as interglacial valleys formed when the land stood higher than at present. The valley of California is described as "a great complex fault trough." No mention is made of the recent anticlinal hills of the Los Angeles Basin.

The paucity of cross sections is disappointing, for, even if highly idealized, they are an immense help in presenting ideas. It would seem that such cross sections might advantageously be substituted for some of the photographs, many of which, particularly those taken from the older reports, are of only mediocre quality. This omission, the failure of the author to express his own opinion on controversial subjects, and the tendency to pass over evidence a little too lightly in favor of conclusions constitute the only faults that have come to the notice of the reviewer.

F. T. THWAITES

THE COAST MORPHOLOGY OF NORTHERN FRANCE

ABEL BRIQUET. **Le littoral du nord de la France et son evolution morphologique.** 439 + 45 pp.: maps, diagrs., bibliogr. Librairie Armand Colin, Paris, 1930. 60 frs. 10 x 6¼ inches.

Briquet's welcome contribution to the science of coastal morphology treats of the shore line of northern France and its evolution by the regional rather than the systematic method; but the presentation is logical and orderly, and the reader, despite the multitude of details discussed in the work, easily keeps in view the author's general plan of elaborating his subject.

An introduction of three chapters places before the reader the general conditions. The origin of the present shore line is ascribed to a partial drowning of the coast,

which permitted the sea to enter valleys previously carved in the land. This part of the treatment loses something from the fact that the particular shore line described is presented more as an interesting but isolated feature, rather than as an example of the well known class of "shore lines of submergence"; and from the further fact that the author does not adequately picture the nature of the land mass submerged—something essential to the best understanding of the resulting shore line. The drowning is represented as having taken place in two distinct phases, separated by a long interval of time. First the Flandrian submergence in postglacial time witnessed a relative rise of sea level amounting to 30 meters or more and ceased several thousand years ago. The second, or Dunkirkian, submergence raised sea level some 4 or 5 meters higher, to its present position, and is believed to have occurred about 1500 years ago. Briquet thus finds for northern France and indeed for all western Europe, as the reviewer has found for America, that the last movement of the sea was upward, rather than downward as Daly has suggested. The amount of submergence is too great in Briquet's opinion to be attributed, at so late a date, exclusively to melting ice; but he finds it difficult to determine the cause with any assurance.

Following establishment of the shore line at each of the two levels indicated, came long periods of stability during which waves and currents accomplished the task of simplifying the original outline. In preparation for the detailed discussion to follow, Briquet devotes a chapter to a general account of the principal processes of "regularization," as he calls the work of simplification. The title of his work speaks of "evolution" of the shore line; but one finds in the extended discussions of shore changes little that relates processes and their effects to sequential stages—youth, maturity, and old age—of a systematic short-line cycle. Apparently the conception of the cycle, which seems so illuminating to American workers on shore problems, does not appeal to Briquet with the same force.

Above the present shore line are found traces of earlier stands of the sea. With commendable caution the author recognizes that the area involved in his study is not sufficiently great to determine the much discussed question as to whether these elevated shore lines indicate an ancient drop in sea level or a rise of the land. But he leans strongly to the former interpretation, widely supported by other French investigators; so strongly, indeed, that he is inclined to accept as evidence of the "35-meter marine level" a single isolated and rather vague break in slope found in his area, between 30 and 40 meters above the present sea (p. 237). He likewise follows the French school in attributing much value to "cyclic valleys" as indications of former sea-level changes, while he seems to look with some favor on a tectonic origin for the English Channel and Dover Strait but without definitely committing himself to this interpretation.

The main portion of the volume is devoted to an elaborate analysis of the shore forms of the maritime plain of Picardy, the Boulogne upland, and the Flemish maritime plain. For each of these three areas there is presented, first, a discussion of the present shore line and the changes recorded for its different parts in the patterns of spits, bars, cliffs, and other features; then an account of ancient elevated shore lines, particularly two found at elevations of 4 or 5 meters and at 15 meters respectively. A concluding chapter gives a résumé of the shore-line history, summing up the salient points set forth in the more detailed analysis of the three main divisions of the work. An extended bibliography and a list of pertinent cartographic references close this part of the text. There follows an appendix of three short chapters dealing with some geographic effects of shore changes and with the utilization of documentary evidence in shore studies. The work as a whole is geomorphic rather than geographic.

Only the shore specialist or persons interested in detailed changes of specific localities on this particular coast can profitably follow all parts of the author's elaborate treatment. But no one will fail to note the great amount of painstaking

research that is represented by this work. The judicial attitude of the author is abundantly evident. One may not always accept his conclusions, but one will at least find food for thought in the discussions on which they are based.

Among the debatable points may be mentioned the validity and age of the last, or Dunkirkian, submergence. Despite the marshaling of evidence by the author (pp. 4–17, 199–205, 224–230, and 355–362) the critical reader may not be convinced that the phenomena described prove submergence amounting to 4 or 5 meters since the Roman epoch. The theoretical discussions in which various marine levels are correlated with successive positions of river beds, the latter represented as always parallel to each other, does not seem to take sufficient account of possible variations in stream profiles due to changes in volume and load. Many features attributed largely to the action of tidal currents are, in the reviewer's opinion, better explained as the product of wave action.

These observations relate, however, to highly controversial matters. The most serious criticism that can properly be urged against their treatment is the author's failure to take larger cognizance of the foreign literature dealing with shore processes and shore-line evolution. This literature is abundant and would have shed valuable light on many of the questions treated. In so excellent a monograph one is disappointed to find no reference to Gilbert's classic shore studies, Davis' analysis of the fulcrum idea applied to Cape Cod, or Gulliver's "Shoreline Topography," although these works deal at length with problems discussed by the author and sometimes explained by him in a manner not concordant with earlier interpretations. On the other hand, the bibliography of the local regions described is particularly abundant and testifies to a broad and deep knowledge of earlier studies of the areas treated. Altogether, Briquet has given us a clearly written and highly valuable account of an example of shore-line evolution which is particularly interesting to the student of shore forms because of the extent to which successive stages of development can be dated by historic documents.

DOUGLAS JOHNSON

THE NATURAL FEATURES OF CZECHOSLOVAKIA

Československá Vlastivěda (Czechoslovakia in All Its Aspects), Vol. I: **Príroda** (The Natural Features). 641 pp.; maps, diagrs., ills., bibliogrs., index. "Sfinx" Bohumil Janda, Prague, 1930. $8.00 each volume. 10½ x 7½ inches.

On the request of the first Congress of the Czechoslovak University professors, a series of eleven volumes, covering all aspects of the present Czechoslovak Republic is now being published in Prague under the auspices of the Masaryk Academy of Work. The volumes are respectively entitled: (1) The Natural Features; (2) Man; (3) Language; (4) History; (5) State; (6) Work; (7) Literature; (8) Art; (9) Industry; (10) Education; (11) Agriculture. So far three of them have appeared (1, 6, 9).

The volume on "The Natural Features" is composed of twenty-one articles written by eighteen collaborators under the editorship of Dr. František Slavík. The articles are grouped in two sections. The first section, "Geomorphology," deals with the situation of Czechoslovakia, describes its land forms by major regions, and elaborates on certain special features. The second section, "Physical Geography," deals in turn with orography, hydrography, weather and climate, cartography, geodesy and geophysics, rocks and minerals, the geology, the soil, the mineral wealth, the fauna, a geobotanical survey, and the conservation of scenery.

The treatment is exhaustive, and many hitherto not too well known facts are brought to light. For example, in Czechoslovakia landslides are far more frequent than is generally realized. They occur in rainy periods under prolonged or exceptionally heavy rains when the phenomena may assume almost catastrophic proportions, as, for instance in the spring of 1926 at Mnichovo Hradiště near Boleslav.

Landslides are most frequent in the Cretaceous region of Bohemia, in the Boleslav region, and in the Středohoří (Mittelgebirge), for instance; also in the Ostrava district in Moravia and especially in the flysch ranges of the Moravo-Slovakian Carpathian Mountains. It has been found that the periodically recurring landslides correspond to years with exceptionally abundant rain.

There are neither deserts nor true steppes in Czechoslovakia, but there occur certain phenomena characteristic of arid regions. There are sand hills or dunes in the valleys of some of the larger rivers—Danube, Morava, Labe (Elbe), etc.—where they most probably originated in the dry periods of later Pleistocene or subrecent times. These forms, originating in certain very permeable sandstones and limestones, have been named "pseudoarid" by Dr. V. J. Novák. The sandstones of the Upper Cretaceous of Bohemia are, furthermore, traversed by two systems of vertical joints and disintegrate into large square blocks, giving rise to picturesque scenery, for instance in the neighborhood of Broumov, near Hradec Králové, and Jičín and Turnov, respectively east and north of Boleslav. Pure limestones giving rise to karstic phenomena are limited in Bohemia to a few small districts. Much more important is the karst of Moravia, in the Middle Devonian, with such famous caves as those of Sloup and the near-by chasm of Mococha, 136 meters deep. In Slovakia karst occupies a still larger area, the largest of these districts lying on the boundary with Hungary, where the known passages of the great cave of Baradla measure 8½ kilometers in length. Also well known is the cave of Dobšiná, a large part of which is filled with ice.

There is an interesting discussion of the extent and character of the Pleistocene glaciation. The mountain glaciation presents two different types according to the morphological features of the mountains. The old Bohemian massif in the west with its broad ridges developed in places a glaciation of the type represented in the Norwegian fjelds. In the Carpathian Mountains valley glaciers of Alpine type prevailed.

Because of the National Parks movement in America, it is interesting to note that a like movement was existent in Bohemia in 1914 when a Congress of Czech physicians and scientists passed a resolution in its favor.

The volume is attractively produced and illustrated with 611 photographs in addition to numerous charts, diagrams, bibliographies, and a hypsometric map on a scale of 1 : 2,000,000. The work as a whole shows Czechoslovak scholarship at its best, and the editor must be complimented upon the spirit in which he has undertaken a difficult task.

JOSEPH S. ROUCEK

THE EARTH AS MODIFIED BY HUMAN ACTION

NIKOLAUS CREUTZBURG. **Kultur im Spiegel der Landschaft: Das Bild der Erde in seiner Gestaltung durch den Menschen: Ein Bilderatlas.** xvi and 218 pp.; ills. Bibliographisches Institut, Leipzig, 1930. RM. 45. 11 x 15 inches.

PAUL SCHULTZE-NAUMBURG. **Die Gestaltung der Landschaft durch den Menschen.** Vol. 1, 158 pp.; Vol. 2, 176 pp.; Vol. 3, 153 pp.; ills. 3rd edit. Georg D. W. Callwey, Munich, 1928. M. 22.50. 10½ x 8 inches.

These two works represent attempts to show graphically man's part in changing the landscapes of the earth. It is the belief of the authors that photographic studies of cultural landscapes lend themselves to such analysis as enables us better to distinguish the good from the bad and the beautiful from the ugly. Such studies make it possible for us to determine what works of man fit harmoniously into nature's setting and perhaps eventually to attain an ideal end in this respect. A few parts of the earth are still untouched by man. However, for the most part the earth's surface has been disturbed, and man continues to keep it constantly in a state of

change. Both studies seek to classify the cultural landscape, that of Schultze-Naumburg being more detailed than Creutzburg's.

The title of Creutzburg's work, "Culture Mirrored in the Landscape," effectively epitomizes the objective of its contents. The author recognizes not only current changes but also man's cultural evolution as reflected by successive changes in the landscapes of given localities from early times down to the present. Cultural landscapes are not readily wiped out. In America landscapes are simple, but in the Mediterranean they are most complex. In the latter region remnants of a succession of civilizations still are visible. The most recent cultural forms reveal the influence of the machine; what changes this device will ultimately effect remains of course to be seen.

We are accustomed to interpret the cultural life of a people in terms of literature, music, and art, but culture may be reflected even more truly in the development of the landscape. Certainly, as an index to man's progress, much in the landscape provides concrete evidence of his attainments. The modifications of the earth's surface grow toward each other in a physical sense and finally resolve themselves into the natural landscape to constitute an integral part of it. If civilization declines, then nature begins to displace the cultural changes and, if permitted to act long enough, conceivably returns the land to or nearly to its original state.

Creutzburg classifies the landscapes under four main headings as follows: (1) modifications of the water areas, (2) clearing and planting of the land, (3) industrial development and settlement in the open country, (4) cities as landscape forms. Numerous subdivisions are included under each major heading.

In Schultze-Naumburg's work, Part I discusses country roads and city streets, the plant realm, and the significance of the latter in the general landscape. In the realm of the plant world one cannot help being impressed by the numerous types of landscapes which may be classified but which for the average observer have no distinguishing characteristics. The forest itself, the landscape with alternating forest and farm land, the meadow with scattered groups of trees, or with an isolated tree here and there, are but a few of these types. "Rhythmic effects" are seen in the rows of trees set along roadways or in symmetrical planting in the cottage yard. Then too, there are the winter landscapes as distinct from those of summer.

In Part II the geographical aspects of the land are noted with special reference to utilization of minerals and man's activities on the waterways. Where open pit mining or quarrying has been in operation the surface forms obviously have been changed, sometimes for better and sometimes for worse. Land forms along the seashore consisting of dunes or cliffs or low coasts are contrasted and compared. River valleys, waterfalls, rapids, dams, and man-made lakes receive consideration. Wells and springs in villages do not escape attention. The attraction of settlers to these waters is graphically portrayed. Styles and types of bridges and the materials used in their construction present interesting studies.

In Part III landscapes associated with industrial development and those of settlements themselves are given attention. Factory buildings both ancient and modern, with transformations in the forms of the structures, are illustrated. Various phases of railroad engineering both in cities and in mountains present a fascinating photographic story. Finally, landscapes involving urban forms both old and new offer a large and attractive array of views—small towns, large cities, fortified centers, and areas of concentrated industries.

The photographs in both works are well executed and apparently have been carefully selected. They are presented in ample variety to give substantial support to the author's running comment. These volumes should be of peculiar interest to the geographer, who finds more and more value in the detailed photograph as an aid in defining the landscapes he studies. The magnificently executed aerial photographs of the Creutzburg volume should fill with enthusiasm even the most indiffer-

ent observer. The day cannot be far distant when such works as these will become not only aids to the teaching of geography but even integral parts of geographical study. Again the preparation, according to the patterns here represented, of many travel volumes and other books that lend themselves readily to illustration will save the public much reading time while elucidating ideas more effectively than does much of present literature.

EUGENE VAN CLEEF

CLIMATOLOGY OF SOUTH AMERICA

K. KNOCH. **Klimakunde von Südamerika.** viii and 349 pp.; maps, diagrs., bibliogr. (Handbuch der Klimatologie, Vol. 2, Part G.) Gebrüder Borntraeger, Berlin, 1930. RM. 67.50. 10½ x 7 inches.

This is an extremely useful book. There is a dearth of climatic data for the whole northwest of South America, but in the last two decades there has been an increase in knowledge of the rest of the continent. This new knowledge Knoch's book sets before us.

It falls into three main parts of 94, of 153, and of 79 pages respectively; the first part a description of general features of the climate in South America, the second a detailed treatment by countries, and the third consisting of fundamental tables with a nineteen-page bibliography.

There is no index of topics or places, for which omission the publishers deserve censure. However, in the regional and principal part of the book the orderly arrangement of countries does something to mitigate this fault. It is to be hoped that the forthcoming volume on North America will not suffer this defect.

The work is sound and scholarly. Vertical temperature gradients are studied by monthly values at thirteen pairs of stations in the Andes and other mountains, showing a range from 0.70° C. per 100 meters at Caracas to 0.19° at Guayaquil.

There is a wealth of maps on the scales 1 : 70 million and 1 : 54 million. There are maps of temperature at surface and sea level, anomalies and annual range. There are similar maps of pressure and pressure amplitude, maps of mean cloudiness for summer and winter, of the rainfall for every other month and for the year, graphs of rain at 20 stations, maps of summer and winter location of drought, and of the number of days with thunderstorms. The only annual map here published is that of rainfall. Others were prepared but omitted as not in the "working plan of the publisher." This annual rainfall map is a distinct advance on all of its predecessors. All of the maps are wonderfully clear and easily read.

The main part of the book is the description of climates by regions—Cordilleran states and eastern states taken in order from north to south. There is very little quotation from residents or travelers, about ten pages in all. Most of the descriptions are the less vivid references of indirect quotation, which leave much to be desired: for instance, the author uses none of Darwin's excellent descriptions.

The tables at the close are a delight to any student. There are monthly and annual means of temperature and rainfall at 216 stations, with annual rainfall at 260 more; monthly and annual pressure at 80 stations; monthly percentages of wind directions at 57; monthly and annual means of relative humidity at 131 points, and mean monthly vapor pressure at almost as many; the monthly mean wet thermometer readings at 40 places; monthly mean cloudiness at 123; monthly mean numbers of clear days and cloudy at 30 places; monthly mean number of days of fog at 54 places, and of rainy days at 119; the monthly mean number of days of snow at 12 places, and of hail at 23; monthly and annual numbers of thunderstorms at 94 points; anomalies of pressure every month of every year at Georgetown, Rio, Cuyabá, Córdoba, Buenos Aires, Santiago, Salta, Punta Arenas; and, finally, the rainfall of each year for 24 places, the longest series being Santiago 1867–1924,

La Serena 1869–1920, Fortaleza 1849–1920, Rio 1851–1925, and Buenos Aires 1851–1924.

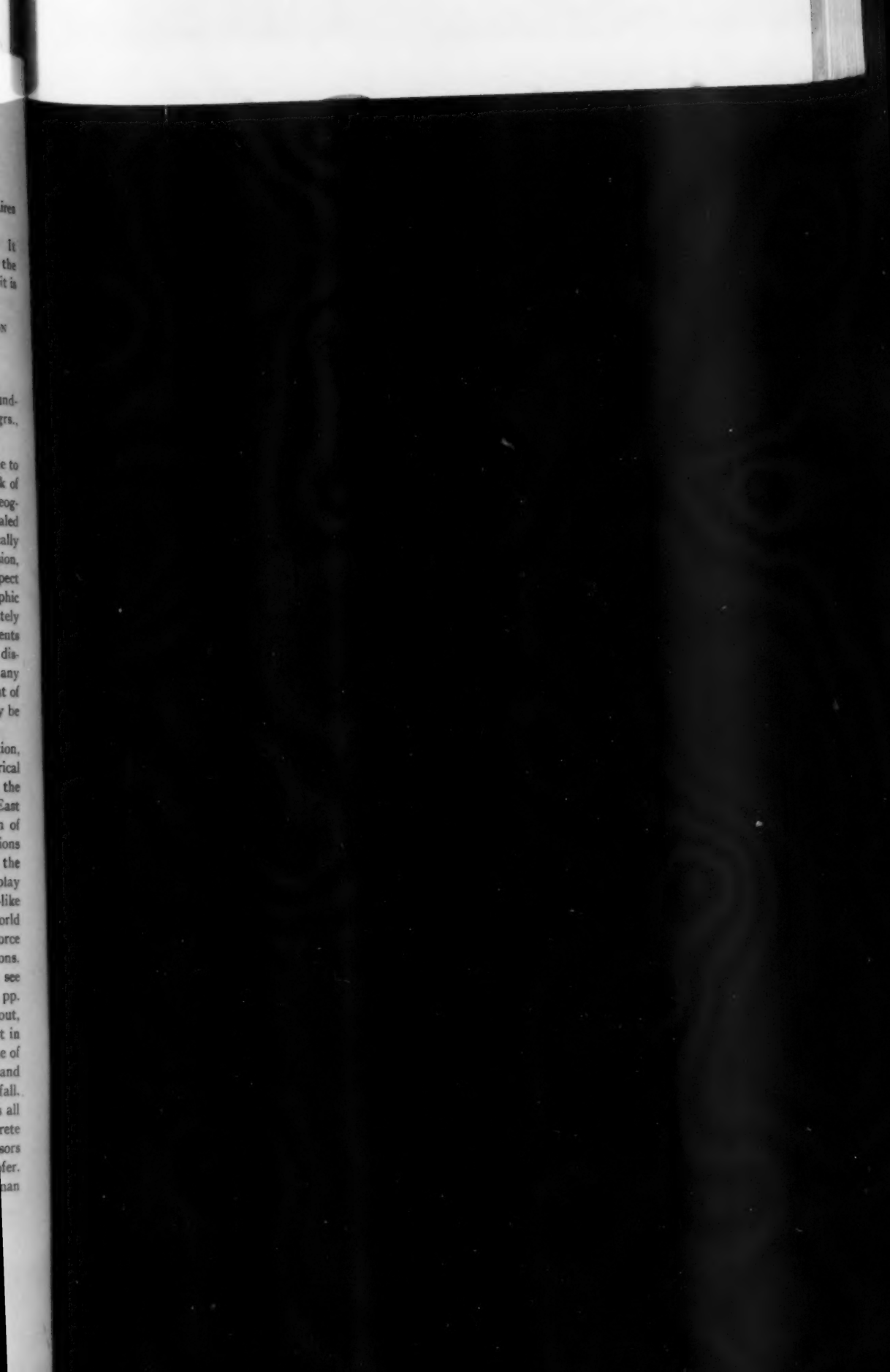
The author's lack of personal familiarity with the continent is regrettable. It may be doubted whether general readers will be able to get much of an idea of the climate at particular points from the book, yet to students of American climates it is quite indispensable. It is the only work on the subject and a good one.

MARK JEFFERSON

KJELLÉN'S POLITICAL GEOGRAPHY OF THE GREAT POWERS

KARL HAUSHOFER, edit. **Die Grossmächte vor und nach dem Weltkriege.** Zweiundzwanzigste Auflage der Grossmächte Rudolf Kjelléns. 348 pp.; maps, diagrs., ill., bibliogr. B. G. Teubner, Leipzig and Berlin, 1930. 8½ x 6 inches.

The popularity of Kjellén's book (it is now in its 22nd edition) is obviously due to its balanced and systematic description of the political world. It is a textbook of the briefer type, including an outline of each important complex in political geography. Events and conditions are sketched, and the facts about them marshaled and described rather than deeply analyzed. The points of view (characteristically German, though Kjellén was a Swede) are deftly expressed in suggestion, allusion, quotation, and map symbolism, where they are not explicitly stated as in respect of the peace following the World War. Unlike most other politico-geographic writers of similar convictions, he but rarely resorts to exclamation marks. Definitely critical of present arrangements, he tries to take a judicial position. Judgments are not built up on an elaborate basis of argument; they are dropped into the discussion as if the reader's assent could be taken for granted. And it is not in any sense a book of judgments; rather, it is a presentation of facts from a given point of view. The mark of the careful student is upon it everywhere, but it can hardly be called a book of original thought.

Briefly described, its material falls, in outline, into four categories: (1) position, resources, and political and economic tendencies of the Great Powers (with historical backgrounds sketched in) before the World War; (2) the World War; (3) the new alignment of the Great Powers, including additional sections on the Far East and Latin America; (4) the outlook for the Great Powers. The last section of fifteen pages is the most thought-provoking part of the book. Its generalizations are of the broadly philosophic variety: the growth of the great-power idea, the will-to-power combined with space and numbers to support the idea; the interplay of imperialistic and socialistic ideas in the modern world; the alleged Janus-like quality of the League of Nations, looking on the one hand toward the ideal of world peace and on the other toward an Anglo-Saxon hegemony that aims through force to retain the advantages of victory and build upon the old imperialistic foundations.

For the setting of the book in Kjellén's work as a whole, the reader should see Robert Sieger's obituary notice in the *Zeitschrift fur Geopolitik* (Vol. 1, 1924, pp. 339–345). Kjellén's dependence upon German predecessors is there brought out, and the reasons are given for his sympathy with the German school of thought in "Geopolitik." Essentially his purpose (in a series of books of which this was one of the most substantial) was to discover the nature of the forces that play upon and within a state to bring it to high destiny or cause its curtailment or its downfall. People and land and political concepts and economic and industrial conditions all affect the functioning of a state, and he sought to express that functioning in concrete terms. In the revision of Kjellén's work for editions that followed his death, Professors Hassinger, Maull, and Obst have collaborated with the editor, Professor Haushofer. The result is that the book presents the best existing statement of current German thought in the field of political geography.